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To
Prof. L. Agapiz,
With the kind regards
of the Author.

Senatobia Mex.

January 30th 1861. —

PHYSICAL AND MORAL ASPECTS OF GEOLOGY.

By W. J. BARBEE, A. M., M. D.,

PRESIDENT OF M. F. INSTITUTE, SENATOBIA, MISS.

THIS work is designed for popular use. The terms used by Geologists are explained so that the leading principles of the science may be understood by the general reader.

There are many works upon Geology, of great ability, yet there is still wanting a short, comprehensive treatise, embracing a familiar exposition of its fundamental facts and principles, and a discussion of the moral aspects of the science. This work accomplished this object with singular directness of purpose, and in a manner which will prove agreeable to every reader.

In examining the moral attitude of the science, the author shows that there is no conflict between the Bible and Geology, but between the deductions of Geology and mistaken views of Scripture.

The writer has availed himself of all the researches of English and American authors on this subject—the State Reports of Geologists, assisted by twenty years of personal observation in various portions of our country.

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PART I. treats of Geological Dynamics—under which head the author treats of the changes which have been effected by the agency of *Air, Fire, Water, Chemical Action, Electricity, Vital Action, and Death*. The agency of these great forces is simply, yet beautifully, explained.

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His ten arguments on the Antiquity of the Globe—his seven arguments on the Noachian Deluge—and his Chapter on the Bible and Geology, and the Benevolence of the Deity argued from the structure of the Earth, will be found deeply interesting to all who desire to maintain the truth of God's Word, and who believe that His Word and Works can never come in conflict.

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THE
PHYSICAL AND MORAL
ASPECTS OF GEOLOGY.

CONTAINING THE
LEADING FACTS AND PRINCIPLES OF THE SCIENCE,
AND A
DISCUSSION OF THE GREAT MORAL QUESTIONS
GROWING OUT OF
MODERN GEOLOGICAL DISCOVERIES.

BY
WM. J. BARBEE, A. M., M. D.,
PRINCIPAL OF M. F. INSTITUTE, SENATORIA, MISSISSIPPI.

~~~~~  
SPEAK TO THE EARTH, AND IT SHALL TEACH THEE.—*Job.*  
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TO
EDWARD HITCHCOCK,
THE
CHRISTIAN GEOLOGIST,
THESE PAGES
Are Respectfully Inscribed
BY
THE AUTHOR.

(iii)

P R E F A C E.

I PUBLISH this book at the urgent solicitation of a number of friends. The manuscript has been prepared amid the perplexities of business, and the arduous labors of the school-room.

The design of the publication is expressed in the title-page, — to present to the public something which could be readily understood, and to excite the popular mind to further investigation.

We have many excellent books on Geology — works of great ability,—but there is yet wanting, as it appears to me, a short treatise containing a familiar exposition of the fundamental facts and principles of the science, *together with a discussion of the moral questions involved in the science.*

Will any one say to me, “Dr. Hitchcock has published an able book, entitled ‘Religion of Geology?’” I am aware of it. I have read it with great satisfaction. But, observe, that in this book of Dr. H., there are no elementary principles laid down, and the popu-

(v)

lar reader who has never studied the elements of the science, feels at a loss in comprehending many portions of the treatise.

The same objection exists against the admirable works of Hugh Miller. Within the last three years I have heard more than a hundred men declare their enthusiastic admiration for the great Scotch Geologist, at the same time confessing that they could not understand more than one half of what he said.

It may be said that these men could understand him by purchasing and studying some text-book on the subject. Very true. But how many men will do it? Not one in ten.

Believing, therefore, that a small book, containing the elementary principles and an exposition of the moral aspects of the science, would be acceptable, I have consented to appear as an author.

In the preparation of this book I have availed myself of all the resources within my reach—the systematic treatises of English and American authors—the State reports of our Geologists, and my own personal observation, made in several States during a period of twenty years.

W. J. B.

SENATOBIA, MISS., Aug. 1860.

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THE
PHYSICAL AND MORAL
ASPECTS OF GEOLOGY.

CHAPTER I.

Introductory, History, Character, Prospects and Utility of Geology.

GEOLOGY treats of the structure of the Earth—the arrangement of its strata, minerals, and fossil remains; and of the causes which have induced the changes that have taken place since the original Creation.

It is a branch of human knowledge which commands the respect and admiration of the philosopher and Christian—a science which has enrolled among its votaries men of genius and talent, both of the present and past century—a science which has made its contributions freely to advance our knowledge of the great globe we inhabit—one which displays the power, wisdom, and goodness of the Creator;

one which brings to light what, long anterior to the human era,

“The vast unfathomed caves of ocean bore.”

It is a science which strengthens the intellect, elevates the morals, refines the taste, and contributes to the wealth of nations and the progress of civilization.

The history of Geology exhibits three important periods—*ancient*, *medieval*, and *modern*. The first reaches from the earliest ages to the close of the fifteenth century—the second extends from that time down to the close of the last century—and the third from the last date to the present time. The first is the period of hypothesis—the second the period of philosophical speculation—and the third the period of induction.

It will afford both pleasure and instruction to sketch these periods and present them in comparative estimate—to note the difference between the fancies of Aristotle and the facts of Humboldt—the conjectures of Pythagoras and the observations of Agassiz—the ideal of Plato and the real of Lyell.

We must be content with a rapid view. Our object is not minute detail, but the citation of certain prominent facts with a view of arriving at important conclusions.

1st. The Egyptian Philosophers entertained the opinion that, at the beginning, the water had covered the whole surface of the earth, and retired to the interior cavities of the globe, remaining in the great abyss, ready to issue forth, and produce the most extensive inundations. They also surmised that the earth was subject to occasional conflagrations; and by a succession of deluges and conflagrations, the Gods arrested the wickedness of men.

These fancies seem to have been borrowed from the Hindoo cosmogony, which teaches that Brahma the creator fell asleep, waked up, and found the world a vast expanse of water, and proceeded to reduce it to order.

2d. Aristotle, founder of the Peripatetic Sect, first clearly defined the four elements, "Fire, Air, Earth and Water." From the mutual contact of different bodies arises a mutual action and passion, each endeavoring to reduce the other to its own likeness.

In sensible bodies there are certain primary qualities, some active and others passive, which constitute their specific difference. Of this kind are heat and cold, moisture and dryness, heaviness and lightness, hardness and softness, roughness and smoothness.

It is from the union of the first two of these pairs

of primary qualities that the elements are formed; fire, from the union of heat and dryness; air, from the union of heat and moisture; water from the union of cold and moisture; and earth from the union of cold and dryness. Mixed bodies are formed by a combination of all the elements. Thus, from his principles of production and dissolution, Aristotle endeavors to assign the causes of natural appearances.

3d. Plato, leader of the Academic Sect, devised and defended a strange theory of the Universe. The Universe, he supposed, was one animated being, including within its limits all animated natures. In the formation of the visible and tangible world, fire and earth were first formed, and afterwards united by means of air and water. The world will remain forever, but by the action of its animating principle it accomplishes certain periods within which everything returns to its ancient place and state. This is called the "Platonic" or great year.

4th. Pythagoras, of the Italic Sect, contended that the material world was an animated sphere, beyond which was a perfect vacuum. It contains spheres which revolve with musical harmony. The atmosphere of the earth is a gross, immutable, morbid mass, but the air which surrounds it is pure and healthful, the region of all divine and immortal

natures. The earth is inhabited by man,—the sun, moon and stars, by gods and demons. In accordance with these fancies are his symbols, a few of which I here present: “When it thunders, touch the earth.” “Sail not on the ground.” “Look not in a mirror by the light of a candle.” “Break not bread.” “Plant not a palm.” “Abstain from beans.”

It is due, however, to the memory of the great Samian philosopher, to state that he made a number of observations upon the changes which are continually taking place upon the surface of the earth. He noticed, for example, that valleys have been excavated by running water, and floods have washed down hills into the seas,—that land has been submerged by earthquakes—that peninsulas have been divided from the main land—and that plains have been upheaved into hills.

5th. Epicurus conceived that the formation of the world might have happened thus:—A finite number of that infinite multitude of atoms, which, with infinite space, constitutes the universe, falling fortuitously into the region of the world, were, in consequence of their innate motion, collected into one rude and indigested mass. In this chaos the heaviest and largest atoms or collections of atoms first subsided, whilst the smaller and those which

from their form would move most freely were driven upwards. These latter, after many reverberations, rose into the outer region of the world and formed the heavens. Those atoms, which were by their size and figure suited to form fiery bodies, collected themselves into stars. Those which were not capable of rising so high in the sphere of the world, being disturbed by the fiery particles, formed themselves into air. At length, from those which subsided, was produced the earth. In the first combinations of atoms which formed the chaos, various seeds were formed. The world is preserved by the same mechanical causes by which it was framed, and from the same causes it will at last be dissolved. This is pure Atheism — as good as that of modern times.

Medieval. — Coming down to more modern times, we observe that Descartes conceived that the globe might originally have been composed, like the sun, of the pure element, fire — but that by degrees its less subtle parts had gradually collected together and formed thick and obscure masses at its surface similar to those accumulations which occasion the spots discernible on the sun. Different crusts were thus formed, and from the falling in of parts of the exterior crust into the cavity beneath, the irregularities of the earth's surface were produced.

We notice, next, the conjecture of Leibnitz, who conceived the earth to have been a luminous mass, gradually cooling, surrounded by steam, which by condensation fell in the form of water, so as to cover the highest mountains.

We may read the amusing fancy of Whiston, who supposed the earth was originally a comet; the still more laughable conceit of Buffon, that it was a portion of the sun, struck off by the mighty force of a comet, which had the impudence to approach the center of the Solar System, and demand an unconditional surrender of a portion of his territory, that this was given up, and became annexed to the planetary union.

Let this suffice, for a notice of the hypotheses of learned men touching the origin of our globe.

We wish to make one or two reflections:—1st. No power of genius is adequate to the discovery of truth by a conjectural course of reasoning, when it was intended by the Author of all being that such truth was to be discovered by observation. 2d. Philosophers must bow submissively to revealed truth.

We have seen, from our brief historical sketch, that the master spirits of the five most distinguished schools of Grecian philosophy labored to devise theories which would account for the formation of

the earth and for several of the phenomena of the material universe. They failed. — Why? They began with a hypothetical cause; they built their arguments upon a shadow. Ideality took the place of reason. They did not interrogate Nature, but dictated to her. Hence, all their labor was in vain. No being was made wiser by their instructions. No good was effected.

Again, — they were ignorant of the inspired narrative concerning creation. They knew not Him who spake and it was done, who commanded and it stood fast. They had not read the sublime narrative which says, “In the beginning God created the Heavens and the Earth.”

“Philosophy, baptized in the pure fountain of eternal love,
Hath eyes indeed; and, viewing all she sees as meant
To indicate a God to man, gives him his praise,
And forfeits not her own.”

I come now to speak of the third great epoch in geology — the epoch of induction. It is familiar knowledge to any intelligent reader, that inductive philosophy had its origin in the labors of Lord Bacon. In the second part of his “Instauration of the Sciences,” styled “*Novum Organum*,” he lays down this as his leading aphorism : —

“Man, who is the servant and interpreter of Nature, can act and understand no farther than he has, either in operation or in contemplation, observed of the method and order of Nature.”

Two centuries and a half have passed away since this principle was announced, and elaborated by that illustrious philosopher. Time has not altered it. Time cannot alter it—for it is immutable. It is, in respect of the natural world, a law of research as inviolable as any divine law can be in regard to the moral constitution of man.

It has served as an oracle of wisdom, to direct men in their search for truth. It bade the genius of Newton send out Angels of inquiry to all parts of the universe, and they returned to tell, with one accord, the wondrous truth, that all the bodies of space are controlled by the law of gravitation.

It directed Franklin to send up his paper kite to bring down lightning from the clouds. It told Hunter to study anatomy in the dissecting-room. It enabled Cuvier to reconstruct from the fossil bones, found entombed in a natural sepulchre, the animals of a pre-Adamic age. It braced the wearied limbs of Humboldt as he toiled his way up the steepes of the Andes, the Alps, and the Apennines. It instructed Agassiz to ascend Mont Blanc, and watch for seven successive years the movements of the glaciers. And last, but not least, placed the mind of Lyell in a train of patient investigation, which has resulted in the splendid conception, that all of the phenomena which have taken place on our

globe since creation may be referred to causes now in operation.

Contemplated as a systematic and practical science, geology is of modern origin.

It owes its present important position to the labors of men who have been guided in their researches by the spirit of inductive philosophy. It is almost within the memory of men now living that the first public institution was formed for the purpose of showing to the world the practical utility of this science. This event took place fifty years ago, in the city of London, and it was brought about chiefly by the labors of a single man, who traversed England on foot, and after years of patient observation, could report "that which my eyes have seen, that which my ears have heard, that which my hands have handled, declare I unto you."

At the same time, we have to record a pedestrian excursion in our own country, by one of kindred spirit. The labors of McClure can never be forgotten. He took a view of the United States with staff and knapsack, hammer and chisel. He was a rock-cracker, dirt-scratcher, and shell-gatherer. From the granite hills of New Hampshire to the alluvial plains of the Mississippi he walked his weary way, and gathered from the rich treasures of the earth things new and old.

The beginning of the present century may be regarded as the birth-date of geology. Rapidly has it grown, and widely has it spread. It takes its place among the certain sciences which, with the progress of civilization, have ever been advancing in importance, and in their turn reflected honor, power, and usefulness upon those who have cultivated them.

“Knowledge is power,” but it may be applied to every variety of lever—a power that may build up, a power that may tear down—one that may bless, yet one that may curse. We wish to show that the knowledge of geology is a blessing—that it blesseth him that giveth and him that receiveth—that it enables man to read the thoughts of God “written and engraven in stones,” and that its cultivation contributes to the progress of society. Let me reduce my statements to four propositions:

1st. The study of geology develops the intellectual and moral powers.

2d. It exhibits the natural attributes of God.

3d. It imparts its inductive spirit to the collateral sciences.

4th. It gives freely its assistance to agriculture, manufactures, and commerce.

Prop. 1st. — The study of geology develops the intellectual and moral powers.

There are five leading questions in this science—

1st. Of what is the earth composed?

2d. How are its materials arranged?

3d. What forces have been operative in producing such grand results?

4th. What practical advantage can be obtained by a knowledge of their relative positions?

5th. What use can be made of these different materials?

In directing the mind to these inquiries, all its intellectual powers are brought into active exercise. The physical structure of the globe is laid out before the student. He is brought to behold a mighty fabric, whose accurate formation discloses stupendous design—to gaze with reverential wonder upon the everlasting hills—to study every plain, cavern, and valley—every river, lake, and ocean; every pebble, boulder, and gem; every crystal, metal, and fossil. He is carried back to the ages long anterior to the human era, when revolution after revolution convulsed the globe, and declared to the host above the successive introduction of new epochs. He traces out, in the strata beneath the surface, organic forms which plainly show the unity of God's designs. He sees, written on the enduring tablets of Nature, lithographs that no human hand has traced—types of all the grand divisions of the animal

kingdom, relics of ancient forests, and pictures of ancient gardens. And while contemplating their structure and functions, their position among the stratified deposits, he may reason with all the power of causality, he may imagine with all the power of ideality, he may describe with all the power of language, and adore with all the power of veneration.

With a view of showing to my reader the utility of this branch of natural science, I will now lay down the two following principles or rules—any branch of science, in order to be useful, must possess these requisites:

1st. It must develop the mind by strengthening the intellect and refining the moral powers.

2d. It must give rise to useful arts, and thus distribute its benefits to society.

Such a science is geology. We claim for it a high position, on the ground of intellectual and moral excellence, and on the ground of practical utility.

1st. It is an intellectual science, for it calls forth the vigorous exercise of the perceptive and reflective faculties of the mind. Its principles are based upon accurate and extensive observation, together with sound induction. It embraces facts and their philosophy. It directs the inquirer to look, hear, touch, taste, and smell; to analyze, compare, contrast, judge, and decide; to trace effect to cause, and

cause to effect: in a word, to perform all the higher operations of intellect. Hence it follows that the thorough geologist is a man of profound and extensive attainments. He is not merely a fossil-collector or a pebble-gatherer. Indeed, one may travel the world over, visit every mine, explore every mountain, survey every valley, look at every organic remain, and yet be no geologist. He may make a brilliant display of minerals, talk the technicalities to an astonished gazer, and yet be a superficial amateur or a self-conceited quack.

We discover in this department of natural science two classes of cultivators — philosophers and empirics. The former reason, the latter do not; the former “read sermons in stones,” the latter see no sermons to read; the former collate, generalize, and deduce, the latter collect, arrange, and admire; the one is comprehensive, the other limited; the one is profound, the other shallow. I might speak at some length of the qualifications of a geologist. I must be content with saying, in a few words, that he must be at once a linguist, a mathematician, a chemist, a zoologist, a botanist, and a logician.

In the second place, geology is a moral science; it exhibits the power, wisdom, and goodness of God in creation, confirms revelation, and gives honor to Him “who covers himself with light as with a gar-

ment; who stretches out the heavens as a curtain; who layeth the beams of his chambers in the waters; who maketh the clouds his chariot, and who walketh upon the wings of the wind." It elevates and refines the feelings, and improves the moral sentiments. The man who fails to see the beauties of geology, or who cannot discern the grand moral truths which are here presented, is "blind, and cannot see afar off."

But I have said that geology is a science of practical utility. Every useful science must give birth to a useful art. English grammar is a science, and out of it grows the art of using words in a proper sense for the communication of ideas. Arithmetic is a science; its resultant art is book-keeping, without which commerce could not thrive. Geometry and trigonometry are sciences, and from them we have the useful arts of surveying, engineering, and navigation. Chemistry is a science, and truly she is the mother of a good family—assaying, agriculture, bleaching, calico-printing, dyeing and painting, and various manufactures. Every farmer, and planter, and mechanic, and professional man—yes, every being in civilized society—is deeply indebted to every man of science who has given his discoveries to the world.

What a laughable spectacle it would be at this

•

day, to see all the Southern planters sending off their bales of cotton in ox-carts, load by load, to the nearest stream, to be shipped in flats or keels to the great Southern depôts! And yet such might have been the case, had not Savory, Newcomen, and Watt, and Fulton, and their distinguished successors, told the world how to use that mighty power which, in the language of Webster, "rows, pumps, excavates, carries, draws, lifts, hammers, spins, weaves, and prints."

What a fearful stagnation of business would occur in the commercial world, did England stop her manufactures! And yet such an event might have taken place, had not Sir Humphry Davy, many years since, discovered the miner's safety-lamp. We might thus proceed with details; but enough has been said to demonstrate the proposition laid down, and I will now proceed to show that geology takes rank with all the useful sciences in dispensing blessings to society. The practical importance of the science whose claims we are endeavoring to urge may be easily discovered by a statement of these two facts:

1st. God has constructed the earth upon a well-defined plan. He has a place for everything, and everything is in its place.

2d. He has made it for the use of man.

For popular and economical uses, we may arrange most of the materials which come under our notice in the following order:

1st. Earthy substances, as Clay, Loam, Marl, Sand, etc.

2d. Minerals, as Nitre, Soda, Gypsum, the precious stones, etc.

3d. Rocks, as Granite, Sandstone, Limestone, Coal, etc.

4th. Metals, as Gold, Silver, Copper, Iron, Zinc, etc.

5th. Fossils, as Petrified Shells, Fish, Corals, and Bugs.

Now these things are not thrown together with confusion, but are arranged in order, so that he who studies the order may know how and where to find anything he wants. Do men gather grapes of thorns, or figs of thistles? Does the oak-tree bear grapes, or the vine acorns? We live not in a world of chance; and if upon its surface, since the dawn of the historical period, man has been enabled to "live, and move, and have his being," because of the supreme wisdom which has caused a succession of seasons, the growth of plants and animals, the early and latter rain, and the wonderful regularity of the solar system, no less is he dependent for his existence and happiness upon the same Divine wisdom

which, for countless ages prior to the human era, was engaged with matchless skill in constructing the various formations that constitute our globe.

Geology, then, may be contemplated both as a science and an art. As a science, it presents and unfolds a multitude of facts and principles, all of which enable us to discover the systematic structure of the earth. As an art, it enables man to search with accuracy for the mineral treasures of the earth. It bids him seek every mineral in its proper locality, and not go blindly digging in marl-beds for gold, or in alluvium for coal. It exhibits to him the crust of the earth, made up of a series of rocks, which lie in a regular order of position, bearing their various mineral fruits. And as the orchardist points without difficulty to his hundred varieties, as the merchant lays his hand with ease on any one article of a thousand, as a librarian selects in a moment a particular book out of ten thousand volumes, so may the geologist direct the inquirer to rocks producing gold, to rocks producing silver, to rocks producing copper, to rocks producing coal. He tells the miner where to sink his shaft, and many a crazy gold-seeker would be saved an immensity of labor and misery by taking heed to his counsel. He bids the architect be cautious in selecting his material; he advises the engineer where to run his road, and

he instructs the agriculturist how to manage his ground.

A word or two of fossils. They are beautiful things, and always excite the admiration of every person of taste. In the language of an eminent author, they are the "medals of creation," and they speak a language to the geologist which fills his soul with ecstasy. But in addition to this, they have an economical value. Every formation is characterized by its peculiar fossils. Here, for example, is a fossil—a bivalve shell—found in the formation below coal. It is never found in it or above it. Suppose, then, we were searching in an unexplored region with a view of finding coal, and should find this fossil. What have we to do but to stop? We may as well look for diamonds in a bird's nest as to examine for coal one moment longer in such a locality.

Geological Literature.—Seventy years ago there was scarcely a book on the subject. Now the name of the books is Legion. From the little duodecimo, that a baby could carry, to the ponderous quarto, that would kill baby, if it would fall upon him.

Encouraged by Institutions of Learning.—When I was a boy, I never heard the name. It had not been imported from England. When I was a Sophomore, I received a letter from a friend, stating, "I

am studying geology." What is it? Just the same as geography, I suppose. Our professors were men of learning—but they knew about as much of geology as a fossil mastodon does of a Tennessee corn-crib.

Now we have professorships and professors, lectures and recitations, &c. &c., all over the country.

Geological Surveys.—Nearly every State in the Union has her State Geologist, and from the many surveys which have been made in the last twenty-five years, the conclusion is drawn that the system pays very well. These surveys develop the mineral wealth of a State—show what she has got, and what she does not possess, and they point out the best methods of cultivating the earth.

I propose to divide my treatise into three parts:—

PART I. — contains an account of the Elements of the globe, and an Exposition of Geological Dynamics.

PART II. — contains a Classification of Rocks, and a description of the different formations.

PART III. — treats of the Moral Bearings of Geology.

P A R T I.

ELEMENTS OF THE GLOBE.

GEOLOGICAL DYNAMICS

(33)

CHAPTER II.

**The Earth regarded as One of the Bodies of Space—Its Density—
Surface—Crust and Interior—Temperature.**

WHEN we study the Earth as a planet, regarding it as a part of the solar system, we contemplate a mass of matter suited by its form, density, and position, to hold its place among the globes that move round the sun, joining in the “music of the spheres,” to praise the God of Heaven, and declare his glory to man.

The constituent parts of the earth, their relative position, or the utility of any one of the materials of which it is composed, does not enter into the investigation. All these topics belong to Geology.

The Earth, the third planet from the Sun, is an oblate spheroid. Its equational diameter is about 8000 miles, and its polar diameter about $26\frac{1}{2}$ miles less. Its circumference is about 25,000 miles.

The Diurnal Motion of the Earth gives us day and night in regular succession—just what poor mortals want. They would die without it. Just

what inferior animals want, and the very thing for vegetables.

The Annual Motion of the Earth, in its orbit of six hundred millions of miles, at the rate of sixty-eight thousand miles per hour, gives us a succession of seasons—another important consideration for the animal and vegetable kingdoms.

Flatten the earth to a great plain, according to the notion of the cotemporaries of Pythagoras,—arrange it as Ptolemy did, or put it where the sun would really revolve around it, according to the opinion of the sapient persecutors of Galileo *—and what would be the consequence? Why, our Geology would all be flattened down to one formation, and there would not be left one man upon the face of such an uninhabitable circle to cultivate the science.

Thanks to the Giver of all good, neither Ptolemy nor the Inquisition had a hand in making our world. God is the Creator.

The density of the Earth is five and a half times

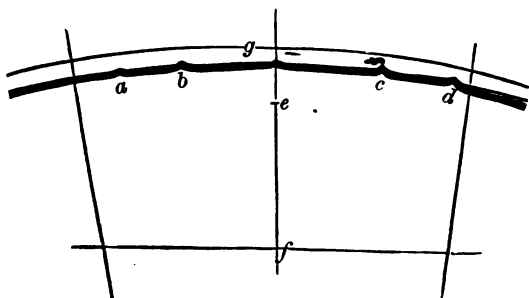
* Both Galileo's work and the work of Copernicus were to be seen on the forbidden list of the Index at Rome in 1828. Mr. Lyell was assured, however, in the same year, that *Pius the VIIth* had procured a repeal of the edicts against Galileo and the Copernican system. He had assembled the Congregation, and it was proposed by Cardinal Toriozzi, "*that they should wipe off this scandal from the Church.*" The repeal was carried with one dissentient voice.—*Vid. Lyell's Principles of Geology*, 9th ed., foot-note, page 56.

as much as water—that is, it weighs five and a half times as much as a globe of water having a diameter of about 8000 miles. This density increases from the surface towards the interior, so that at the depth of thirty-five miles air would be as dense as water, and at 360 miles water would be as heavy as quick-silver.

The surface of the earth is quite irregular, notwithstanding its irregularities do not prevent a general rotundity. Humboldt estimates the mean height of the solid parts of the earth at about one thousand feet above the level of the ocean; and the deepest sea-soundings have reached nearly 28,000 feet. The mean depth of the ocean is about one thousand feet.

The crust of the earth is that portion which man has been enabled to explore, and, as just intimated, it is about 10 miles. Theoretically it may extend 30 or 40, or even 50 miles — but practically it will not exceed ten.

The following figure represents the proportion of available crust to the whole globe. The letter *e* shows a depth of one hundred miles; *f*, five hundred miles. The prominences at *a b c d* represent the height of mountains. The line, *g*, is forty-five miles above the surface, the limit of the atmosphere. The thickness of the black line represents ten miles.



The temperature of the globe at the surface has been put down at 50° mean. The increase of temperature from the surface toward the interior, though not uniform in all parts of the earth, may be indicated by one degree for 44 feet.

Proceeding toward the interior, a heat sufficient to boil water would be reached at about 6000 feet; at 48 miles, we would find 7000° , enough to melt rocks; and at the centre of the earth it would be $577,000^{\circ}$.

Hence it has been inferred that all the interior of the earth, except a crust of about 100 miles, is in a state of fusion,—that “in the beginning” the globe was in a melted state; and that the crust has been formed by the radiation of heat.

The reader must bear in mind, however, that this view is *theoretical*, and that geologists are not fully agreed on this subject.

I was once asked by a waggish fellow after I had closed a lecture, "What do you find down in the centre of the earth?" I replied very promptly, "Sir, I never found anything. I never extended my observations that far." The audience dispersed with a merry laugh.

CHAPTER III.

Comparative View of Astronomy and Geology in reference to Philosophical Induction.

It is a striking truth that all the great advances made in acquiring knowledge, and in the development of the arts and institutions of society, have been from the *known* to the *unknown*; and, on the other hand, retrograde movement has always been from the UNKNOWN to the KNOWN.

The crab moves from the unknown open daylight of the shore back to his native element.

The plodding ox-driver, who vehemently declares that rail-roads are a modern innovation upon the great highway of his fathers, looks with contempt upon the Iron Horse as he moves along twenty miles per hour, and falls back, with wonderful contentment, into his ancient vehicle that makes two miles in the same time. The great net-work of Iron Rail from the St. John's to the Rio Grande — the men — the money — the commerce — the prosperity — all is to him an *unknown* complication. But there is one

thing he knows. He knows how to drive *Buck* and *Brindle*.

The boy at his mother's knee, with open primer before his curious eye, advances from his well-known mother's voice to the "great unknown" alphabet, and thus progressing, he advances through every stage of learning, aye, to good old age; and when at last he yields his spirit up, he advances from the present, the *known* present, to the *unknown* future.

The order which God has established for the development of the mind itself, is also the order in the discovery of the facts and principles of Physical Science.

To illustrate this important principle, let us notice some of the leading features of Astronomy and Geology.

1st. Astronomy is based upon observation. So is Geology. The Astronomer takes his telescope and looks far away at the bodies of space as they move in their orbits, or remain fixed in the position assigned them by divine wisdom. He notes down facts and draws his inferences. The Geologist takes his hands and his feet, his five senses—hammer and chisel, a few chemical tests, and goes to work. The planet he proposes to examine is not far off. He needs not the telescope to bring it near. He can feel it, see it, taste it, smell it, and hear it. He can

walk about Vesuvius, ascend its peak, and look down in its crater. He can make deep sea-soundings—dredge the Atlantic, and bring up hidden things from the bottom of the ocean. He can take his position on a pile of rocks, and from that standpoint he is enabled to discover truth and beauty. He can scour the mountain-range, and examine with care the rich variety of material placed before his eye. And, when wearied with his wanderings, he can sit down and hold communion with the past.

2d. The Astronomer reasons by analogy. So does the Geologist. The Astronomer tells you that as the Earth, illuminated by the Sun, revolving on its own axis, and moving in its orbit round the great centre, is inhabited by intelligent beings and inferior animals, so must Jupiter, lightened by the same sun—revolving on his axis and going round the great centre—also be inhabited; and you declare his reasoning plausible. How much more plausible then is the argument of the Geologist, which teaches us that as the Earth is now fitted for the abode of human beings and inferior animals, so likewise there were immense epochs prior to man, during which the Earth was undergoing gradual changes, adapted to the existence of the myriads of animals that have passed away and left their remains buried in the rocks of a million hills.

3d. But there is something more than beautiful analogy in the reasoning of the Astronomer. So there is in the reasoning of the Geologist. The distinguished German Astronomer, John Kepler, who is often styled "the Legislator of the Heavens," after numerous observations, made chiefly upon the movements of Saturn, arrived at certain great conclusions touching planetary motion, and these conclusions he expressed in the form of laws, the truth of which is admitted by all the scientific men of the world.

Let us, for our present purpose, notice his third law. I copy from a popular text-book.

KEPLER'S THIRD LAW.—*The squares of the planet's times of revolution round the sun are proportioned to the cubes of their distances from the latter.*

For example, Mercury's year consists of 88 days; Venus's of 225 days. Mercury is 36,890,000 miles from the sun, and Venus 68,770,000. Then the following proportion holds good, or nearly so.

$$(88)^2 : (225)^2 :: (36,890,000)^3 : (68,770,000)^3.$$

Now observe that Kepler's process of reasoning embraced three grand stages. 1st. Observation. 2d. Deduction. 3d. Generalization.

In the first place he observed the motions of Saturn.

In the second place he deduced his laws for the motion of that planet.

In the third place he applied the law to all the planets.

And what is there, I ask, in this philosophy of planetary motion—the mathematics of celestial harmony—but the exhibition of a principle that pervades all space, and regulates all the kingdoms of nature?

Examine this principle in all its relations—from the mild action of running water in the little valley to the heaving and roaring of old ocean; from the growth of the modest violet to the large development of the forest oak; and from the structure and functions of *Infusoria* to the nervous sensibility and muscular action of man—and you find written on the tablets of nature, *Persistence of Law; Like Causes produce like Effects; Similarity of Structure necessitates similarity of Function*. Trace back the great principle by the aid of Revelation, and your mind halts with adoration at the throne of God, who creates by miracle and governs by law.

Let us for a moment apply it to geological research. Behold the geologist walking forth to institute a series of investigations. He takes his position on the coast of Sweden, and observes *Upheaval*. Again, he stands on the coast of Greenland, and

there he observes *Subsidence*. He continues his observations through a period of thirty-three years, and finds the same phenomena in various parts of the world—yea, further; he finds, by consulting the records of history, that similar facts have been recorded, though by men who had no idea of the principles of geology as developed in modern times. What deductions does he make? *Upheaval* and *Subsidence* have been going on ever since the creation of man. It is a law of the globe in its relation to man.

One step further. *Upheaval* and *Subsidence* is a law of the globe in all its phases, and during all its epochs, from the remotest period back in the “night of time,” during all its changes prior to the human era, up to the present hour, when man stands on the earth, last and greatest exhibition of Divine skill.

Here we have the same steps of reasoning as in the case of the astronomer.

The first step is *Observation*, the second is *Deduction*, the third is *Generalization*.

In the third place, the astronomer shows that order and harmony characterize the universe. It is the delight of the geologist to point out the exhibitions of order and harmony discovered in the structure and functions of rocky strata, and in the

myriad forms of beauty found in the imbedded fossils.

There is a strange idea of the original chaos, and its rapid subjugation, existing in the minds of many intelligent persons. It may be represented by an accumulation of mud, stone, marble, shells, bones, sticks, granite, gravel, gold, iron, copper, marl, chalk, coal, fire, and water, all piled up in one confused mass, until the Almighty spoke, and each mineral and metal took its place, and order was restored in the twinkling of an eye.

The idea is presented by Milton, when he puts the following language in the mouth of the angel describing creation :

“They viewed the vast immeasurable abyss,
Outrageous as a sea, dark, wasteful, wild,
Up from the bottom turned by furious wiuds
And surging waves, as mountains, to assault
Heaven’s height, and with the centre mix the pole.
Silence, ye troubled waves; and thou, deep, peace,
Said the omnific Word; your *discord* end.
. And God said,
Let dry land appear.
Immediately the mountains huge appear
Emergent; and their broad, bare backs upheave
Into the clouds, their tops ascend the sky.”

Now, we read that the earth was “wasteness and emptiness;” and we also read that the dry land did appear; but we nowhere read that there was such

an "outrageous" abyss, or that the mountains jumped into sudden form. All this is a poet's fancy.

Finally. The astronomer shows us the proofs of the power, wisdom, and goodness of God in the starry heavens. The geologist does the same in his sketches of the physical history of the earth; and, if we mistake not, the contributions of geologists to natural theology, made in the last twenty-five years, have done more to enlarge our conceptions of Almighty power and goodness than all the works of mere sectarian theology of the past three hundred years.

No man can examine the proofs of a Providence superintending the animate creation of all the ages of the earth's history, as brought to light by the Christian geologist of the present day, and not be deeply impressed with a sense of Divine benevolence — vast and unfailing goodness.

But we do suppose a man might examine all the documents controversial pertaining to church authority, or man's natural and acquired ability, or sublapsarianism and supralapsarianism, together with many other isms, and never for a moment think of the goodness of Him whose tender mercies are over all his works.

It is an oft-quoted remark of Sir J. F. W. Herschel, that "geology, in the magnitude and sublimity of the objects of which it treats, undoubtedly ranks next to astronomy in the scale of the sciences." We candidly think that it is coequal, and we doubt not some of our readers will agree with us.

CHAPTER IV.

Elements of the Globe, and their Combinations—Classification of Minerals.

WE learn from the science of chemistry that there are about sixty-two elements entering into the composition of our globe; and that sixteen of the sixty-two, by a great variety of combinations, enter largely into the structure of our planet.

We will enumerate these sixteen, and then say something of their combining properties, and the laws which regulate them. They are Oxygen, Hydrogen, Nitrogen, Fluorine, Chlorine, Carbon, Sulphur, Phosphorus, Silicon, Aluminum, Potassium, Sodium, Calcium, Magnesium, Iron, and Manganese.

1. *Oxygen*, from its great abundance and wide diffusion, is entitled to the name of *Autocrat of the Elements*. It constitutes from 30 to 50 per cent. of the crust of the earth, and forms one-fifth of the atmosphere and eight-ninths of water. It is without color, taste, or odor. Except when influenced by chemical action, it remains unmoved in the mineral

kingdom ; but by vital action, it is freely eliminated by the vegetable, and gives support to the animal kingdom.

2. *Hydrogen*, a favorite companion of oxygen, is a light, volatile gas, having little weight, but a mighty influence. Without it we should have no water to gladden the earth and give nourishment to man and beast, no water for arts and manufactures, no water to move the wheels of commerce, and bring the ends of the earth in close communion.

3. *Nitrogen* forms 80 per cent. of the atmosphere, and is also found in combination with various animal and vegetable substances. When set free by chemical decomposition, it is a life-killing thing ; but combined with oxygen, it is the vehicle of life, and health, and beauty.

4. *Fluorine* occurs in fluor-spar and other minerals.

5. *Chlorine* is found in great abundance in the ocean, being one of the elements of salt (chloride of sodium).

6. *Carbon* enters largely into the formation of all kinds of coal and various bituminous substances.

7. *Sulphur* is found in its pure mineral state near volcanoes. Large quantities of it may be obtained at Naples, in the island of Sicily, and in several of the Sandwich Islands. It is also found in combina-

tion with iron, lead, and copper; likewise in eggs, hair, horn, and hoofs.

8. *Phosphorus* is never found in nature free, but combined with oxygen and lime. It is contained in most fertile soils, and in a number of vegetable and animal substances.

9. *Silicon*, next to oxygen, is the most abundant element of mineral matter. Never found free, it is widely diffused with oxygen, and enters into the composition of siliceous rocks, quartz, sandstones, flints, sand, gravel, and sandy soil. When combined with oxygen, it is called *Silica*.

10. *Aluminum* is the metallic base of *alumina*, which is found in every soil.

11. *Potassium* is the base of potash, found diffused in rocks and soils, in animal and vegetable substances.

12. *Sodium* is the base of soda, from which we obtain a great variety of salts.

13. *Calcium* is the base of lime, whose combinations are legion.

14. *Magnesium* is a white metal, of great brilliancy, and forms the metallic base of magnesia, the salts of which are so common in mineral waters.

15. *Iron* is the most popular and the most useful metal we have. Pure native iron is often found; but generally it exists in the shape of *ore*, of which

there are several varieties. From the days of Tubal Cain till now, iron has been the servant of man. Without it agriculture, manufactures, and commerce would languish and die. Hence it is an indispensable element of civilization. It is on the land, blazing the road, felling the forest, raising the sod, planing plank, baking bread, cutting pork, and roasting turkies. It is on the rivers, and by its aid the moving palaces bear along a million of souls. It is on the ocean, and the man-of-war moves over the dark-blue waters, under its protection, fearless of danger, and rejoicing in strength.

16. *Manganese* is a hard, brittle metal, of a grayish-white color, always found in combination with other elements — principally oxygen.

These are the sixteen simple bodies that compose ninety-nine hundredths of the mass of the globe. They all have their mission to fulfil. The Psalmist says of Jehovah, "He maketh the winds his ministers, — his messengers a flame of fire." So, too, of these elements: we may say they are his ministers — his angels of the physical world. And they are sent forth to minister to the wants of organic existence, from the lichen on the old oak-tree to him who has been made a little lower than the angels.

Notice their diffusion. Look at oxygen. You may take the wings of the morning, and fly to the

uttermost parts of the earth, and oxygen will accompany you. Rise to the point of perpetual congelation, and there you will meet it. Then plunge into an ocean Hades, and emerge from the deep; it is a witness of your baptism — fit emblem of the omnipresence of God!

It glitters in the dew-drop of the morning, sparkles in the crystal of quartz, dances upon the plain, and plays upon the mountain-top — fit emblem of the goodness of God!

It began its career when the morning stars sang together, far back in the beginning of the pre-Adamite ages, and has witnessed every revolution which has taken place since — fit emblem of the wisdom of God!

Observe, in the next place, their *combinations*.

To one not accustomed to think upon the subject, it may appear strange that nearly the whole globe, with all its varieties of solid, liquid, and gaseous substances, is made up by a multiform combination of sixteen simple substances. But it is true. Permutation is a law of nature as well as art. Twenty-six letters or elements form the English alphabet. Taken alone, each one is of little service. Combine them, and you have the great Anglo-Saxon language — the court-language of five continents.

Seven primary notes constitute the music-scale.

Sound one, and another, and another, without making a chord, and you hear the dull, monotonous tone. Combine them in harmony, and you have the solemn music of the sacred choir, the fascinating strains of the opera, and the sublime tones of the oratorio.

Here we may introduce a well-known principle of mathematics,—permutation,—and come at once to the question, how many arrangements can be made of sixteen elements? The answer can be ascertained in a few minutes—twenty trillion, eight hundred and seventy-nine billion, one hundred and nine million, eight hundred and eighty-eight thousand.

Is it strange, then, that by the combination of these elements, Almighty wisdom has made for our use some six or seven hundred mineral substances?

We may proceed to notice that some substances are made of one simple element, as carbon, iron, and gold. These may be called *Monomials*.

Some are composed of two simple elements, as quartz and water. These may be styled *Binomials*.

Some are composed of three simple elements, as carbonate of lime. These we call *Trinomials*.

Some are composed of four or more simple elements, as granite. These we style *Polynomials*.

Let us now direct our attention to a few laws of combination.

I. *The composition and properties of compound bodies are unchangeable.*

This law applies to every mineral substance, as well as to organic bodies. It is one of the decrees of the Almighty, and we may contemplate it as a physical demonstration of his immutability. Any compound, as long as it retains its peculiar properties, will always yield, under analysis, the same elements combined in the same proportions. "Water, a compound of one part of *hydrogen* and eight parts of *oxygen*, possesses certain well-known properties. Now, whenever and wherever a substance is found possessing the various properties of water, we know, from this law, that it must be a compound of these two substances, united in the above proportion; and whenever a compound of these substances, in this proportion, is formed, it must possess the peculiar properties of water."

II. *When any substances (as B. C. D., etc.) combine with a given quantity of another substance (A.) then the numbers which represent the proportions in which B. C. D., etc., combine with A, will also represent the proportions in which they will combine with each other, if such combination be possible.* Thus,

8 parts of Oxygen	}	Combine with 1 part of Hydrogen.
35.4 " Chlorine		
16.0 " Sulphur		
127.0 " Iodine		
80.0 " Bromine		

It follows, therefore, that if oxygen and chlorine combine, it will be in the ratio of 8 parts of the former to 35.4 parts of the latter, etc. etc. The numbers thus obtained for the various substances are called their *combining numbers* or *equivalents*.

III. *When two substances combine in more proportions than one, then these different proportions will always sustain some simple ratio to each other.*

To illustrate this law, let A and B be two substances capable of combining with each other in several proportions;—the lowest proportion in which they combine will be in the ratio of one equivalent of each, or 1 A and 1 B. The other compounds they form will be of the character 1 A + 2 B, 1 A + 3 B, 1 A + 4 B, etc.; that is, one equivalent of one substance will be united with 2 or 3 or some exact number of equivalents of the other substance.

The compounds of *Nitrogen* and *Oxygen* afford an excellent illustration of the above law.

1st compound contains Nitrogen 14 and Oxygen 8					
2d	"	"	"	14	" 16
3d	"	"	"	14	" 24
4th	"	"	"	14	" 32
5th	"	"	"	14	" 40

IV. *The equivalent of a compound substance will always be equal to the sum of the equivalents of the substances which compose it.*

If water is composed of 1 equivalent of oxygen, 8,

and 1 equivalent of hydrogen, 1, its combining number will be $8 + 1 = 9$. The same is true of all compound bodies.—*Johnston's Turner's Chemistry.*

Let us now notice the leading combinations actually made among these elements, and we shall readily discover that the materials of the globe are made up by a very few and comparatively simple associations of simple bodies. Still further we may notice that, according to our calculation,—all these planets and fixed stars of the universe may be composed of the same materials, combined in various ways, and constituted so as to fulfil the varied functions assigned them by Eternal Wisdom.

For a fuller exhibition of these combinations we must refer the reader to the text-books of chemistry.

TABLE I.—FORMATION OF BINARY COMPOUNDS.

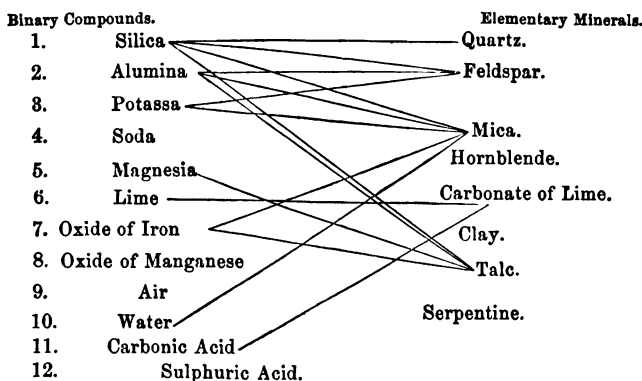
Non-Metallic Simples.	Metallic Bases.	Binary Compounds or Oxides of Bases.
Oxygen.	Silicon.	Silica.
	Aluminum.	Alumina.
Hydrogen.	Potassium.	Potassa.
Nitrogen.	Sodium.	Soda.
Carbon.	Magnesium.	Magnesia.
Sulphur.	Calcium.	Lime.
Chlorine.	Iron.	Oxide of Iron.
Fluorine.	Manganese.	Oxide of Manganese
Phosphorus.	(O. & N.)	Air.
	(O. & H.)	Water.
	(O. & C.)	Carbonic Acid.
	(O. & S.)	Sulphuric Acid.

The combination of oxygen with the metallic bases is indicated by the lines, and the combination of oxygen with three of the non-metallic simples is expressed by the initial letters.

The next step leads us to notice the combination of the binary compounds with one another so as to form the prominent mineral substances of the earth. We may regard these binary compounds as proximate elements.

TABLE II.

Formation of the Principal Mineral Substances by the Combination of Binary Compounds.



The various combinations of the binary compounds make the elementary minerals.

TABLE III.

Formation of the Great Masses of Rock stratified and unstratified, by the Combination of Elementary Minerals.

Elementary Minerals.

1. Quartz (Q.)

2. Feldspar (F.)

3. Mica (M.)

4. Hornblende (H.)

5. Carbonate of Lime (C. L.)

6. Clay (C.)

7. Talc (T.)

8. Serpentine (S.)

Rocky Masses.

Granite (Q. F. M.)

Gneiss and Mica Slate (Q. F. M.)

Trap (F. & H.) or Basalt.

Porphyry (F.)

Lava and Pumice (F. melted.)

Clay slate (Q. F. & M.)

Buhr stone (Q.)

Sandstones (Q. & C.)

Limestones (C. L. & C. L. & C.)

Sand (Q. pulverized.)

Marl (C. with some C. L.)

The composition of the rocky masses is indicated by the initial letters of the elementary minerals.

Thus, *Granite* is composed of *Quartz*, *Feldspar*, and *Mica*.

TABLE IV.

Classification of Mineral substances in seven families

The true basis of classification is chemical constitution.

Professor Dana's arrangement is the best for popular appreciation, while at the same time it is strictly in accordance with scientific principles.

Seven Classes.

CLASS I. { Air. Carbureted Hydrogen. Sulphuretted Hydrogen.
Gases. { Nitrogen. Phosphuretted " Muriatic Acid.

CLASS II. *Water.* Rain, River, Lea, Snow, Ice.

CLASS III. { Coal, Jet, Amber, Diamond, Graphite, Bi-
Carbon and Compounds. { tumen in various forms of Pitch, Rock Oil,
and Naptha.

CLASS IV. *Sulphur.* Native Sulphur. Sulphuric Acid, etc.

CLASS V. { Salts of Ammonia, Potash, Soda, Baryta, Strontia,
Haloid Minerals. { Lime, Magnesia and Albumina.

These are compounds of alkalies and earths with the soluble acids, such as sulphuric, nitric, carbonic, etc.—as, table salt and common limestone.

CLASS VI. { Silica or Quartz, Lime, Magnesia, Alumina, Glu-
Earthy Minerals. { cina, Zirconia, Thoria.

These embrace all the siliceous or aluminous compounds of alkalies and earths. It is under this head that most of the choice minerals of cabinets are arranged.

1. Oxydizable Metals.

CLASS VII. { Cerium, Yttrium, Uranium, Iron, Manganese, Chro-
Metals and { mium, Nickel, Cobalt, Zinc, Cadmium, Bismuth,
Metallic Ores. { Lead, Mercury, Copper, Titanium, Tin, Molybde-
num, Tungsten, Tellurium, Antimony, Arsenic.

2. Noble Metals.

Platinum, Iridium, Palladium, Gold, Silver.

The minute study of all these mineral substances—their crystalline structure,—luster, color, specific gravity, hardness,—their chemical properties, etc., belong to the science of *Mineralogy*.

CHAPTER V.

Geological Dynamics—The seven great Forces, 1, Air; 2, Fire; 3, Water; 4, Chemical Action; 5, Electricity; 6 and 7, Life and Death.

GEOLOGY is the anatomy and physiology of the earth. It professes to describe the structure of our globe, the causes or agencies which have been in operation for countless ages in bringing about the great structure which we behold before us, and the functions, so to speak, of the various systems or formations into which the whole mass of the globe has been divided.

We propose, in this chapter, to consider the seven great forces which have contributed to the working of those wonderful changes that have occurred since the original creation of the world.

How the world was created, we cannot tell. On this subject we are willing to remain in ignorance until it may please the Creator to reveal his plan in another state of existence. An eminent American author appears to think he has made the discovery. Hear him.

“God puts his simple activity in counter-agency. He makes act meet and hold act, and in this originates an antagonism which constitutes force ; a new thing ; a something standing out for objective manifestation, and holding itself in position as a reality distinct from his own subjective simplicity. This force fixes itself in position ; holds itself at rest ; and, so far from being inert, its very existence is a *vis inertiae*, or a force actively holding itself still. Combined with this act against activity, in the same limit of counteraction, is the diremptive activity, that works conversely to the antagonism, and which, though hereafter to be considered distinctly, may now for the present be apprehended as in unity, and the antagonism and diremption to be the one agency of the Absolute Spirit in one and the same limit of their action ; the antagonism working each way into the limit, and the diremption working each way out from the limit, and both making, in their interaction, a compound material substance, which has the *disparting of the antagonism* in the diremption between the counterworking activities, and the fixing of the diremption by the antagonism on each side of the divellent activities. There is thus the combination of three of the molecular forces in one limit—the diremption works each way out from the limit, and thus counterworks with an antagonism coming

up each way in the limit, and thereby two antagonisms and one diremptive force equilibrate each other, and fill and hold the space they have taken. Any considerable extent of space so filled—a cubic inch, or a cubic mile—is a creation of matter palpable to the senses, impenetrable and substantial.” — *Hickok's Rational Cosmology*.

We have but one objection to offer to this theory of President Hickok—it is, to our mind, utterly incomprehensible. We are therefore incompetent to decide upon its merits.

We may venture to suppose that God first created elements, and then combined these elements according to the laws of chemical affinity—the laws of combination of which we have already spoken. How he combined them, we cannot tell. We analyze atmospheric air, and find it composed of oxygen and nitrogen. We may safely infer that the Divine Maker created the elements separately, and afterwards brought them into union; and thus we may reason concerning all other masses of matter. Further than this we cannot go. Here reason must stop, confess her ignorance, and bow with reverence. God has virtually said to the reason of man, “Thus far shalt thou come, and no further.” Let us then quote the Psalmist, and be satisfied:—“He spoke, and it was done; he commanded, and it stood fast.”

Leaving the announcement of the sacred historian, that "in the beginning God created the heavens and the earth," without any attempt at exposition further than the suggestion just offered, we pass on to notice, in brief detail, the influence of those agents which have contributed to bring about the physical revolutions of the globe.

These agents are, 1, Air; 2, Fire; 3, Water; 4, Chemical Action; 5, Electricity; 6 and 7, Life and Death.

1. *Of the Air.* — The still atmospheric air is an agent in producing changes upon the surface of the earth. It is slow, but sure. Strictly speaking, the action is chemical; being the influence of oxygen and carbonic acid, together with the joint agency of heat, and moisture, and cold.

The effect of these influences is expressed by the term *degradation*. Every mountain on the globe shows the effects of atmospheric agency by the degradation which it has suffered. The peeling and blistering of rocks, their actual trituration to powder, the disoxygenation of stones, small and great, and the sliding of the terrible avalanche, are all attributable to the still but powerful influence of atmospheric action.

Such are phenomena of daily occurrence. Limestones, and sandstones, and granite masses have

been worn away to powder by this unceasing agent, the *air*.

If, then, during a short life-time of threescore years and ten, we have seen the huge rocks crumble before our eyes, what a mighty agent air has been through all the ages of the earth's history! And what, we may ask, has been the direction of its influence? It has pulverized the hard rocks, or portions of them, and thus prepared sedimentary material, to be borne off by the waters, and deposited in the depths of the sea, to form new rocks.

Shall we consider for a moment the agency of air in motion? Wind has ever been a considerable agent in modifying the surface of the earth.

“Daughter of darkness!

When sleep weighs down the eyelids of the world,
And life is as it were not, down the sky,
Forth from thy cave, wide roaming, thou dost come
To hold nocturnal orgies.

.

Thou churnest the deep
To madness, tearing up the yellow sands
From their profound recesses, and dost strew
The clouds around thee, and within thy hand
Tak'st up the billowy tide, and dashest down
The vessel to destruction.”

The action of winds is discerned very easily on the deserts of Africa and Arabia. Clouds of burning sand are borne about, and here and there a hill

is made. Sandy sea-coasts are exposed in the same way. The wind sets the sand in motion, and produces a great number of ridges parallel to each other, presenting a slight slope to the wind, and a declivity on the opposite side. The next blast of wind puts all the ridges in motion, and they keep moving, and are constantly advancing upon the interior, about twenty or thirty yards per annum.

The sands of the Lybian Desert have buried ancient cities and temples of Egypt. Hills of blown sand have buried up and excluded the sea, for many hundred years, from the mouths of several small estuaries. Whole caravans have been overwhelmed by sand-storms. Burkhardt informs us that, after passing the Akaba, near the head of the Dead Sea, the bones of dead camels are the only guides of the pilgrim through the wastes of sand.

From what we know of the present, we may reason of the past.

In the pre-Adamite ages wind was a motive power—1st, in forming *hills* upon sandy coasts; 2d, in entombing organic remains, by drifting up the sand; 3d, in felling ancient forests—prostrating large trunks of trees, and leaving them to be buried in the course of ages, to form beds of coal; 4th, in exciting the sea to madness, and driving its waves

against the stupendous cliff, or the sand of the low beach.

Thus has it contributed its influence in bringing about the changes which have occurred upon our planet.

An ancient author says of the Almighty, "He maketh the winds his messengers." The geologist can appreciate the truth of this declaration far better than one who limits his view of this great agent to the human period. The winds have obeyed his voice for a thousand ages.

2. *Electricity*.—This universal, imponderable substance may consist of two fluids, perhaps, Vitreous and resinous; or it may be one fluid in two states, positive and negative; or lastly, it may be a mere condition of matter. It is not the business of the geologist to discuss these *subtle* points. Weightier matters engage his attention.

Electricity has been playing its part for countless years in the physical changes of the earth, not merely in the fearful storm, but in the silent and invisible influence it exerts upon almost every form of matter.

Its effects are mechanical and chemical. If it crushes large trees, and knocks down brick and stone walls, assuredly it may be concerned in removing solid walls of natural masonry, and assist-

ing the wind and the quiet air in the degradation of the massive rocks of the mountain chain.

It is a decomposing agent; resolving water and other substances into their elements.

It "fires up" trees and rocks, and melts refractory metals. On the tops of mountains it leaves its track, perforating hard rocks and melting them to a liquid state.

A few years since it was ascertained that electricity was developed from steam. It follows that in the volcano and hot spring it has been acting its part for ages, with a power that can scarcely be estimated.

3. *Of Water, or Aqueous Agency.*—Water is a powerful agent. This is palpable to every one. The sportive scenes of childhood, and the careful observations of manhood, attest the familiarity of the fact. The heavy drenching rain, the big wide branch, the impassable creek, the floating logs, the sand and mud washed up and deposited "right in the road," the rocks rolled along, the water-fall, the mill-dam and the grist and saw-mills near it, the cut-offs and islands in every brook, demonstrate very plainly that water will make its way through the world, and will leave its mark.

Southey has given an inimitable description of the agency of water, in his remarkable poem entitled

“The Cataract of Lodore.” The author himself had no idea he was making a poetic contribution to the science of geology.

Here is an extract.

“Here it comes, sparkling,
And there it lies darkling;
Now smoking and frothing
Its tumult and wrath in,
Till in this rapid pace
On which it is bent,
It reaches the place
Of its deep descent.
The cataract strong
Then plunges along,
Striking and raging
As if a war waging,
Its caverns and rocks among;
Rising and leaping,
Sinking and creeping,
Swelling and sweeping,
Showering and springing,
Flying and flinging,
Writhing and wringing,
Eddying and whisking,
Spouting and frisking,
Turning and twisting,
Around and around,
With endless rebound.
.
And pouring and waving,
And waving and raving,
And tossing and crossing,
And flowing and going,
And foaming and roaming,
And dinning and spinning,
And dropping and hopping,

And curling and whirling, and spurling and twirling,
And dashing and flashing, and splashing and clashing
And so never ending, but always descending,
Sounds and motions forever and ever are blending."

The agency of water may be considered as four-fold, viz. *solvent, conveying, wearing, and depositing*.

The different forms of water are designated by the familiar names of *Dew, Rain, Ice, River, Lake, and Ocean*.

1st. *Of the Solvent power of Water*.—Water is an omniferous liquid. It will hold in *chemical solution* or in *mixture* almost every thing.

The analysis of mineral springs exhibits the former, and every puddle of water after a rain will show the latter. Iron, sulphur, lime, magnesia, soda, etc., all yield to its dissolving influence. These are very plain facts.

2d. *The Conveying power of Water* is just as palpable a fact as its solvent power. The boy who plays "mill-dam" in the little creek just after a big rain, is as well acquainted with this simple fact as the most learned geologist. But the extension of this power—its action all over the world—its action in all human time—its action in the times before human existence—all these are topics for a head capable of patient observation.

3d. *The Wearing power of Water* may be seen on every road-side and hill-side in the country. The

mechanical force of a stream, together with the solvent power of the water, tears away from its place more or less earthy material, and leaves a gully or ravine.

4th. *The Depositing power of Water* is known to every farmer who has a hilly plantation. The rich soil of the hills is transported from its original place, and deposited in the bottom. Believe it, reader; a larger part of the crust of the globe has been *deposited* almost in the same way. If this is not true, then all modern geology is a falsehood, and its teachers are a set of misguided philosophers. But more of this when we consider the ocean.

It is important to observe the combined action of these several properties of water.

Take a walk in an old field. A heavy shower has lately fallen. The rain—the pure water of the clouds—has mingled its particles with the particles of earthy matter lying on the surface, and it has changed its color. Now it is a dirty, coffee-colored fluid.

That is its *solvent* power.

A little stream is coursing along, winding about among the reeds and bushes, hurrying away to find its level. Gather a cupfull of the water and you will find clay, sand, lime, etc., held in solution. The brook is carrying them all way to a place below. This is the *conveying* power.

Now step along and look at that enormous gully fifteen feet deep, from five to twenty feet wide, and extending from an old rotten fence near the brow of the hill (widening as it goes) down to the level of the small creek that carries the water from the adjoining slopes,—a distance, perhaps, of 300 yards.

Now the water of the little frolicsome stream runs through this gully and out to the creek.

What is the fact about this gully? It has been worn out from an originally unbroken surface.

This is not merely logical inference, but it is a matter of direct observation.

Here then we see the *Wearing power of Water*.

A few steps further, and we are brought to the foot of the slope and right into the creek bottom. What do we see? A *deposit* of mud, sticks, leaves, gravel, sand, loam, etc. etc.

This is the *depositing power* of water.

Now, we believe that since the formation of the world: yea, from that remote period, the beginning of which we cannot estimate with mathematical accuracy, *water* has been the same great element of power which we now discover it to be,—one of the agents of Omnipotence in building a world for the habitation of man.

Far away in Minnesota there is a beautiful lake—an unpretending sheet of water, just large enough

for the sport of the fisherman, or the moonlight amusement of a pleasure party. It has an outlet—a small stream, which moves off with such modesty that one could suppose it intended to take a little ramble and return. But no; it moves on and on, gathering strength as it goes; inviting every stream close by to join it in its journey. From east and west they come, and mingle their waters; and soon the modest stream becomes a mighty river, widening, and deepening, and moving onward, until he becomes a monarch, and asserts his authority. And he stops not until he joins the great congregation of waters in the Mediterranean Sea of the Western Hemisphere. He is the autocrat of the cotton-fields, the settler of boundaries, and the conductor of Southern and Western commerce.

No stream on earth can claim precedence over the Mississippi. It holds in solution, or rather in suspension, trillions of cubic feet of mud, brought from fifteen States of the Union, including an area of one million three hundred thousand square miles. It conveys some four billion of cubic feet of solid matter down to the region of its delta, and there deposits it; and while moving on in its great glory to the Gulf, it wears away the bluff banks of the east, makes large deposits on the shores of the west, converts peninsulas into islands, and forms new

islands by the deposition of its sediment all along its route.

Dr. Riddell, of New Orleans, calculated that "the mean annual amount of solid matter was to the water as $\frac{1}{1243}$ in weight, or $\frac{1}{3000}$ in volume;" and Mr. Lyell, with others, states that the thickness of mud and sand in the delta is about 528 feet, and expresses the opinion that it must have required about 67,000 years for the formation of the whole. He further states that the alluvial plain above the delta, being 264 feet deep, required, by the same calculation, 33,500 years for its formation, and that the whole period, 100,000 years, is insignificant in a geological point of view.

This, we believe, is orthodox geology; and, unless we are greatly mistaken, it has become orthodox theology. At all events, we receive it as a doctrine that cannot be refuted, and we shall pay special attention to the subject in a separate chapter, on the antiquity of the globe.

But there are other things than sand and mud carried down by the Mississippi. "Trees and stones are hurried annually from the mountains to the plains, together with the wreck of countless forests, and the bones of animals which perish in the inundations. When these materials reach the Gulf, they do not render the water unfit for aquatic animals,

but on the contrary, the ocean here swarms with life, as it generally does where the influx of a great river furnishes a copious supply of organic and mineral matter."

The character of our work will not permit us to enter at length upon the consideration of rivers, their alluvial plains, and their deltas. We will close this part of our chapter on aqueous agency by giving an outline of the *deltas of the Ganges and the Nile*; the most of our material being taken from "Lyell's Principles."

The great delta at the Bay of Bengal, formed by the Ganges and Brahmapootra, embraces in its area about 50,000 miles. It is composed of a labyrinth of rivers and creeks (all running out of the two principal rivers), winding about through the alluvium which has been brought down from the hills and plains. The rivers themselves descend from the highest mountains in the world. On the sea-coast there are eight great openings, each one of which has, in turn, been the principal channel of discharge.

Although the flux and reflux of the tide extend even to the heads of the delta when the rivers are low, yet when they are periodically swollen by tropical rains, their volume and velocity counteract the tidal current; so that, except very near the sea, the

ebb and flow become insensible. The great gain of the delta in height and area takes place during the inundations; and during other seasons of the year, the ocean makes reprisals, scouring out the channels, and sometimes devouring rich alluvial plains.

The immense transportation of earthy matter by the Ganges and Brahmapootra is proved by the great magnitude of the islands formed in their channels during a period of forty or fifty years. Some of these originate in obstructions at the bottom, and subsequent deposition; others in sand-banks at points, enlarged, and subsequently cut off by breaches of the streams. Upon these islands the tiger, buffalo, rhinoceros, deer, etc., may be found. Hence animal and vegetable remains become buried in the sediment which subsides in the delta, amid a great commixture of fresh water and marine shells. —*Lyell's Principles*, pp. 275–6.

The quantity of mud held in suspension by the waters of the Ganges and Brahmapootra exceeds that of any rivers of the earth leading to a delta. The quantity of mud borne down to the Bay of Bengal in one year, according to the most accurate estimate that can be made, does not fall short of *forty thousand millions of cubic feet*. This deposit must be continued for forty-five years and three-

tenths, to raise the whole area a height of one foot. The extension of the delta may, however, be prevented by a slight subsidence, such as is evidently going on in Greenland. — *Ibid.*, p. 283.

The Delta of the Nile.—Herodotus says that “the country round Memphis seemed formerly to have been an arm of the sea, gradually filled by the Nile. Egypt, therefore, like the Red Sea, was once a long narrow bay, and both gulfs were separated by a small neck of land.”

The bed of the river undergoes a gradual elevation, varying in different places, and lessening as the river approaches the sea. “The land about the first cataract, lat. $24^{\circ} 5'$, has been raised nine feet in 1700 years; at Thebes, lat $25^{\circ} 43'$, about seven feet; at Heliopolis and Cairo, lat. 30° , about five feet ten inches; and at Rosetta and the mouths of the Nile, still less.”

The mouths of the Nile mentioned by early geographers, have been, many of them, silted up, and the outline of the coast entirely changed.

In consequence of the gradual rise of the river's bed, the annual flood is constantly spreading over a wider area, and the alluvial soil encroaches on the desert, covering to the depth of six or seven feet the base of statues and temples which the waters

never reached 3000 years ago. The arable soil is now greater than at any previous period.

The mud of the Nile, upon analysis, exhibits silex, alumine, iron, carbon, magnesia, and lime. This mud becomes stratified; the upper part of each annual layer consisting of earth of a lighter color than the lower, and the whole separating easily from the deposit of the succeeding year. The mean annual thickness of a layer at Cairo is not greater than a sheet of thin pasteboard; and a stratum of two or three feet must represent the accumulation of a thousand years. — *Ibid.*, p. 262.

Of the Ocean.—The ocean now covers about three-fourths of the earth's surface. The primitive ocean must have spread over nearly nine-tenths of the globe. It has been diminishing in size ever since, by the upheaval of continents and islands; and we have every reason to suppose that it will thus continue to diminish its boundaries for ages to come.

The different tints of the Ocean—blue, green, white, black, and red—are owing to myriads of insects swarming its waters. Its phosphorescence is attributable to the same cause.

Depth.—According to the soundings of Lieutenant Maury, the depths of the Atlantic, for some one hundred miles out from the continents, is about

6000 feet; further out, it varies from 6000 to 25,000 feet.

The Bed of the Ocean, like the surface of the earth, is diversified by mountains, hills, valleys, table lands, and plains.

The Waves, Tides, and Currents of the Ocean are worthy of special notice.

Waves are irregular movements of the water, caused by the wind. They vary in height from a few inches to forty-three feet. They travel at a tremendous rate.

Professor Bache says, "On the 23d of December, 1854, an earthquake occurred at Simoda, on the island of Nippon, Japan. The harbor was first emptied of water; then an enormous wave rushed in, which again receded, leaving the harbor dry. This was repeated several times, and thus several great waves were formed.

"At San Francisco there are several self-acting tide-gauges, which indicate any disturbance in the level of the sea; and these gauges, four thousand eight hundred miles from the scene of the earthquake, marked the time at which the waves arrived. The first one traveled across the Pacific in twelve hours and sixteen minutes, or at the rate of nearly four hundred miles an hour. The others followed at intervals of about an hour each."

The Tides of the Ocean—those remarkable risings and settings of sea-water—are a part and parcel of the great economy of the boundless deep which contributes to a good end.

The height to which the tide rises varies very much in different places. In the Bay of Fundy it is sixty or seventy feet. In most of the ports of the United States it varies from three to fifteen feet.

It is remarkable that the only part of the ocean of sufficient surface and depth to allow the formation of a tidal wave is that which lies south of Australia. When this part of the earth, in its revolution, is brought nearest to the moon, a great tidal wave is made, and then it puts off westward, entering the Indian and Atlantic Oceans, and carrying high water wherever it goes, at the rate of one thousand miles an hour.

Tide-water extends up rivers from fifty to one hundred and fifty miles.

The Currents of the Ocean.—The ocean is full of rivers. There is the *Antarctic current*, a great stream which flows northward from the Antarctic Sea, along the western coast of South America, till it loses itself in

The Equatorial Current of the Pacific.—This stream, having a breadth of more than 3000 miles, flows westward from the American coast on to China and

India. Then, forcing its way among the islands, it joins the equatorial current of the Indian Ocean. Then, proceeding south-west, it makes its way through Mozambique Channel, around the Cape of Good Hope; then northward, until turned west by the coast of Guinea, where it forms the equatorial current of the Atlantic.

The Equatorial Current of the Atlantic, starting at the place just named, proceeds westward to the coast of Brazil, and at Cape St. Roque it divides into two branches. One is called

The Southern Connecting Current, from the fact that, after proceeding along the coast of South America, it turns eastward before reaching the mouth of La Plata, and runs across the Atlantic to the Cape of Good Hope, and then still further beyond, until it is lost in the Indian Ocean.

The other branch of the equatorial current takes a north-western course, and for some distance is styled, from its situation,

The Guiana and Caribbean Current.—It rushes along the coast with tremendous power, and often, pressing through the Caribbean Sea, it enters the Gulf of Mexico, and flowing between Florida and Cuba, takes the name of

The Gulf Stream.—The general course of this stream is north-east. It widens as it goes. It

proceeds along the coast of the United States to Newfoundland, where it branches off—one branch going south-east, until it seems lost in the Atlantic, the other east, to Great Britain; and branching again, a part moves off to the shores of France, and part to the coast of Norway. The waters of the Gulf Stream are much warmer than those of the ocean around it, and they doubtless exert a great influence upon the climate of Great Britain and France.

Lieutenant Maury has given a most accurate and fascinating description of the Gulf Stream in his admirable work on the Physical Geography of the Sea. I beg leave to make a transfer of a few sentences; and if my reader would like a few more of the same kind, he can go and buy the book.

“There is a river in the ocean. In the severest droughts it never fails, and in the mightiest floods it never overflows. Its banks and its bottoms are of cold water, while its current is of warm. The Gulf of Mexico is its fountain, and its mouth is in the Arctic Seas. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or Amazon, and its volume more than a thousand times greater. Its waters, as far out from the Gulf as the Carolina coasts, are of an indigo blue. They are so distinctly marked that

their line of junction with the common sea-water may be traced by the eye."

Several causes appear to be in operation in producing the Gulf Stream.

"There is a constant tendency of polar waters toward the tropics, and of tropical waters toward the poles. These agencies are to be taken into the account. The pressure of the waters forced into the Caribbean Sea by the trade-winds must be regarded. The *galvanic* properties of the Gulf Stream waters are such that there is no admixture of other sea-waters differing in temperature and saltness. The great saltness of its water after the trade-winds have been supplied with vapor from it, and the diminished quantum of salt, which the Baltic and Northern Seas contain, are likewise concerned in producing the Gulf Stream. We have the briny waters of the Gulf of Mexico on the one hand, and the almost fresh waters of the Polar basin, Baltic, and North Sea on the other. In one set of these basins the water is heavy; in the other it is light. Between them the ocean intervenes. But water is bound to seek its level, and the tendency to equilibrium propels the waters of the Gulf toward the Pole."

"The hottest water of the Gulf Stream is at or near the surface; and it gradually becomes less and

less warm until the bottom of the current is reached. The warm waters of the Gulf Stream never touch the bottom of the sea. There is everywhere a cushion of cool water between them and the solid parts of the earth's crust. One of the benign offices of the Gulf Stream is to convey heat from the Gulf of Mexico, where otherwise it would become excessive, and to dispense it in regions beyond the Atlantic, for the amelioration of the climate of the British islands and all Western Europe. Now cold water is one of the best non-conductors of heat; and if the warm water of the Gulf Stream was sent across the Atlantic in contact with the solid crust of the earth, — comparatively a good conductor of heat, — all its heat would be lost in the first part of the way, and the soft climates of both France and England would be as that of Labrador — severe in the extreme, and ice-bound."

Besides the currents or ocean-rivers which we have mentioned, there are others described by hydrographers.

The Arctic Current passes down the coasts of Greenland, and flows by two streams to the Caribbean Sea and the Gulf of Mexico.

The North African and Guinea Current, starting off the coast of Spain, moves down the coast of Africa, and empties into the Equatorial Current.

The Japan Current enters the Pacific from the Indian Ocean, and is very much like the Gulf Stream of the Atlantic.

In a word, there are rivers interspersed throughout the ocean, as on the land, running in every direction, connecting with one another, and sustaining the equilibrium of the whole mass of water.

A Sea within a Sea. — “Midway the Atlantic,” says Lieut. M., “in the triangular space between the Azores, Canaries and Cape de Verde Islands, is the Sargasso Sea. Covering an area equal in extent to the Mississippi Valley, it is so thickly matted over with Gulf weed that the speed of vessels passing through it is often much retarded. When the companions of Columbus saw it they thought it marked the limits of navigation and became alarmed. To the eye, at a little distance, it seems substantial enough to walk upon. Patches of the weed are always to be seen floating along the Gulf stream. Now, if bits of cork or chaff, or any floating substance, be put into a basin, and if a circular motion be given to the water, all the light substances will be found crowding together near the centre of the pool, where there is the least motion. Just such a basin is the Atlantic Ocean to the Gulf Stream, and the Sargasso Sea is the centre of the whirl. Columbus first found this weedy sea in his voyage of dis-

covery, and its position has not been altered since that time."

Counter Currents.—Every current in the ocean has its counter current. This must be so; for if one current carries off millions of cubic feet of water in a short time from a certain part of the ocean, the supply must be kept up or the first current would cease.

The open Polar Sea, the margin of which, at 82° 30' North, was reached by Dr. Kane, is attributable to the warm water of an immense under-current proceeding from the Equator and rising to the surface in the Arctic regions.

Oceanic currents are the great natural vessels of transportation. They carry animal, vegetable, and mineral matter in every direction, and deposit it on coasts and islands, and at the bottom of the sea.

We shall speak of this important function of the ocean streams when we have laid down more material. We must now notice the solid matters of the ocean.

"*The Solid constituents of Sea-water* amount to about $3\frac{1}{2}$ per cent. of its weight, or nearly half an ounce to the pound. Its saltiness may be considered as a necessary result of the present order of things. Rivers which are constantly flowing into the ocean contain salts, varying from ten to fifty and even one

hundred grains per gallon. They are chiefly common salt, sulphate and carbonate of lime, magnesia, soda, potash and iron, and these are found to constitute the distinguishing characteristics of seawater."—*Youman's Chemistry*.

The next series of facts which we present in order to construct a logical argument concerning the grand geological dynamics of the ocean, is taken from the deep sea-soundings of Lieutenant Brooke, and the examination of the various materials brought up from the depths of the water, by Prof. Bailey of West Point.

The following is from one of his letters:

"The specimens examined by me were as follows, viz.:

"No. 1. Sea bottom 2,700 fathoms; lat. $56^{\circ} 46'$ N.; long. $168^{\circ} 18'$ E., brought up July 19, 1855, by Lieut. Brooke.

"No. 2. Sea bottom 1,700 fathoms, etc. etc.

"No. 3. Sea bottom 900 fathoms, etc. etc.

"A careful study of the above specimens gave the following results:

"1st. All the specimens contain some mineral matter which diminishes in proportion to the depth, and which consists of minute angular particles of quartz, hornblende, feldspar, and mica.

"2d. In the deepest soundings there is the least

mineral matter, the organic contents, which are the same in all, predominating, while the reverse is true of No. 3.

“3d. All these specimens are very rich in the siliceous shells of the Diatomaceæ, which are in an admirable state of preservation, frequently with the valves united, and even retaining the remains of the soft parts.”

Soundings have been made in nearly all the oceans and seas of the globe, and, to use the language of Lieut. M., “they all tell the same story, — the bed of the ocean is a vast cemetery.”

The ocean contains countless myriads of animals of every grade, from the microscopic infusoria to the great vertebrated whale that suckles its young.

All these have their day and generation, and then fall asleep. We shall see something about their burial shortly.

We are now prepared for our argument.

Such as the ocean is now, such it ever has been (except in size,) ever since the Almighty passed the decree, “Hitherto shalt thou come, but no further; and here shall thy proud waves be stayed.”

The ocean has always had its currents and counter-currents, its waves and its tides; and “the voice of the great Creator” has been speaking in all its tides and waves and currents, not only since man

began his career on earth, but during all the epochs preceding his existence.

We may here assume, without debate, that the globe was originally in a fluid or nebular state, owing to heat,—that by the radiation of heat a part of the globe became consolidated. A shell or crust composed of granite rocks investing the melted matter was thus formed, and huge basins being made in the crust, proved excellent places for water. In these basins the Creator deposited water, and said to it, “Go to work, — I have much land yet to *form*, nothing to create until the time comes for organic existence.” From that time to this the sea has been doing its Maker’s bidding.

We have said that the agency of water, in general, is fourfold, viz. : *solvent, conveying, wearing, and depositing*. Let us apply our rule to the ocean. Whence came the stratified rocks? From the detritus of the crystalline rocks. How came the detritus? By the *wearing* power of the fast currents and the agency of the atmosphere. But again, how did the water hold it? By its *solvent* power, or by what is equivalent (in a geological point of view,) the power of *suspension*. Still further. How were these materials transported and deposited from their original place in the crystalline rocks to the bottom of the sea? By the conveying and depositing power

of water, as we have illustrated by means of the little brook rattling down the hill-side, and covering the meadow with detritus from the hill-top.

The currents of the ocean—the rivers of the “big water” have borne along their courses mineral materials worn away from the old crystalline rocks, and spread them out into immense beds of sand and gravel and mud, etc., slowly and surely—layer upon layer—until miles have been built up. The currents of the ocean are builders of walls.

When in the lapse of ages continents were upheaved and rivers started from millions of springs—the ocean became the grand reservoir of mineral and vegetable matter borne down from thousands of water-sheds. True to their instinct, the currents have caught it and put it away in a safe place at the bottom, with a positive promise that it should “*turn up*” somewhere and at some time in the coming ages.

The remains of myriads of animals of all classes and sizes are conveyed by currents and “scattered and lodged in the course of time all over the bottom of the ocean.”

The deposition of Fossils is thus explained :

First a layer of mud is formed; then comes a shower of microscopic shells,—they are imbedded; then a mineral layer—perhaps calcareous mud; then some larger shells, and they are imbedded;

and in this way a stratum is formed. Then gravel and sand, etc. etc., are deposited; and then some more mud, calcareous, siliceous, or both in a mixed state; and then more shells and various other organic remains. After resting a long time and becoming solidified, the whole, forming a submarine cabinet, is brought up above the level of the sea by the agency of fire.

Icebergs and Glaciers. — Under the head of aqueous agency, or water-power, it is proper to speak of ice and its influence.

A glacier is an enormous accumulation of ice in the Arctic Circle, or in high mountain valleys in any latitude. Under the Equator, glaciers are found at an elevation of about 16,000 feet.

The most noted glacial territory is the Alps. The glaciers of that region vary in size—in width, from 500 feet to three miles; in thickness, from 100 to 200 feet; and in length, from five miles to twenty.

An iceberg is a floating mountain of ice.

We usually apply the name *glacier* to the large masses of ice remaining on land, as in the Alpine regions; and the name *iceberg* to the hills and mountains of ice which are seen floating from the Poles.

Glaciers move on land, icebergs in the water.

Both contain large and small rocks, — fragments.

broken off from the mountains, — such as granite, syenite, quartz rock, etc.

Glaciers move slowly along, and scratch and groove the rocks over which they pass.

Icebergs float in the ocean, and oftentimes sink down so deep that they scratch the rocks at the bottom.

The long lines of rock melted out and deposited along the bases and edges of a glacier constitute *moraines*.

Icebergs usually melt at 40° latitude, and of course leave their rocky contents deposited at the bottom of the sea.

It is believed by the ablest geologists of this day that the agency performed by *glaciers* and *icebergs* will account for the *Northern drift*, including all the boulders, and the heavy gravel of crystalline pebbles, etc., found all along the Northern Hemisphere, as far down as about 40° north latitude; also for a similar *Southern drift*, found in the Southern Hemisphere, between the Antarctic Circle and 40° south latitude.

It was formerly supposed that an immense deluge had swept these boulders, and pebbles, and gravel over our continent; but, so far as we are informed, this opinion is renounced, and geologists are almost unanimous in adopting the theory of submergence

of land, the deposit of boulders, etc., just as they are now deposited off our coast from floating icebergs, and the subsequent upheaval of the sunken portion of the continents. The proper name of all these boulders and granite gravel is *Drift*.

Diluvium is a name based upon a theory now regarded as false. Hence it should not be used.

4th. *Fourth Dynamic Agent. Fire.*—The action of heat is twofold — mechanical and chemical.

The chemical influence of heat is displayed in the production of gases, the combination of elements, and the fusion of different compounds. These processes are going on continually in the earth, and have been for ages unrecorded.

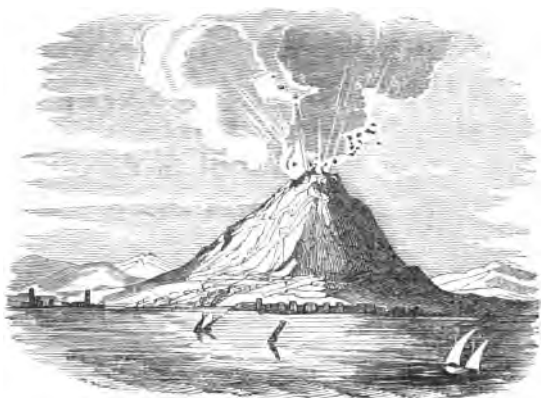
The mechanical influence of this agent is expressed in the familiar aphorism, “heat expands all bodies.”

In applying this simple principle to the subject before us, we have only to consider the earth composed of a crust, not exceeding 100 miles in thickness, and a vast interior, consisting of melted matter. The expansive force of this melted matter elevates land from the bottom of the ocean, and pushes the mountain ridge high up in the atmosphere.

There seem to be three modes by which igneous agency manifests itself: viz., 1. *Volcano*, 2. *Earth-*

quake, 8. *Gradual Elevation and Depression*, or, to use other terms, *Upheaval and Subsidence*.

A *Volcano* is a natural chimney, or vent, through which subterranean fire, smoke, gases, cinders, ashes, stones, and melted mineral matter find their way. These materials,—at least the solid matters,—gradually accumulating around it, form a mountain of a conical form.



Mount Etna.

A short description of Etna, condensed from the narrative of one who has seen it, and thoroughly explored the mountain itself, and all its surroundings, must answer our purpose. A complete essay on volcanoes would fill up our volume.

“Etna rises near the sea, in solitary grandeur, to the height of nearly eleven thousand feet. The

base of the cone is almost circular, and eighty-seven English miles in circumference; but if we include the whole district over which its lavas extend, the circuit is probably twice that extent. The cone is divided into three regions—the *fertile*, the *woody*, and the *desert*; the first comprising the delightful country about the skirts of the mountain, covered with olives, vines, corn, and fruit-trees; the second, an extensive forest, six or seven miles in width, affording pasturage for numerous flocks; the third, a waste of black lava and scoræ, where, on a kind of plain, rises a cone of eruption, to the height of about eleven hundred feet, from which sulphurous vapors are continually evolved.

“There are also minor cones distributed over its flanks, and most abundant in the woody region. They amount to about eighty. On looking down from the lower borders of the desert region, these volcanoes present us with one of the most delightful and characteristic scenes in Europe. They afford every variety of height and size, and are arranged in beautiful and picturesque groups.”

Etna has been an active volcano for some twenty-five centuries.

In 1669, “the lava, after overflowing fourteen towns and villages, some having a population of between three and four thousand inhabitants, arrived

at length at the walls of Catania. These had been purposely raised to protect the city; but the burning fluid accumulated till it rose to the top of the rampart, which was sixty feet in height, and then it fell in a fiery cascade, and overwhelmed part of the city. The wall still remains buried in the lava. The rate of the current's progress was about 162 feet per hour.

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“The subterranean caverns of Etna are very curious, and appear to have been produced by the hardening of the lava during the escape of great volumes of elastic fluids, which are often discharged for many days in succession after the crisis of the eruption is over. Near Nicolosi, not far from Monti Rossi, one of these great openings may be seen, called the Tassa della Polomba, 625 feet in circumference at its mouth, and seventy-eight deep. After reaching the bottom of this, we enter another dark cavity, and then others in succession, sometimes descending precipices by means of ladders. At length the vaults terminate in a great gallery, ninety feet long, and from fifteen to fifty broad, beyond which there is still a passage, never yet explored. The walls and roofs of these great vaults are composed of rough and bristling scoriæ, of very fantastic forms.

“At the base of Etna we find marine strata of clay, sand, and volcanic bluff, cropping out from beneath the modern lavas. The marine fossil shells of these strata are identical with species now inhabiting the Mediterranean; and, as they appear some 600 feet above the sea, they clearly prove that there has been an upward movement of the ancient bed of the sea. The whole mountain, with the exception of the most modern portions, has doubtless participated in this upheaval.”

There are about two hundred active volcanoes at present; but this number is small when compared with the number of extinct volcanoes. From all the information we can obtain touching volcanic action, we are authorized to believe that it is a part of the great economy of nature.

Volcanoes give vent to the melted matter lying beneath the crust of the earth, and thus, by discharging their contents through hundreds of chimneys in various localities, usually near the sea, they prevent the awful explosions which would otherwise occur everywhere, and which would render the globe uninhabitable.

Volcanoes elevate and fracture plain strata, so as to render them bent, broken, and displaced.

Such are the great functions of these terrible fires in the historical period, and such, doubtless, have

been their functions in the ages preceding human life.

Of Earthquakes. — From a close examination it seems there are three kinds of movement in earthquakes, not all coexisting, but variously manifested — sometimes one only, sometimes two, and very rarely the three.

The first is *perpendicular*, acting from below, upward. Bodies of men have been thrown upon a hill several hundred feet high by this motion.

The second is *horizontal*, consisting in undulations regular and uniform.

The third is *rotatory*, causing a whirling motion of the earth, twisting buildings and displacing other objects.

An earthquake usually moves at the rate of twenty or thirty miles in a minute, *on* a line from 100 to 1500 miles long and from 50 to 100 miles wide.

A few facts will be cited.

November 7th, 1857, *Valdiria, Chili*, was destroyed by an earthquake. Captain Coste, commander of a whaler, went on December 11th following, to a spot near the island of Lemus, where he had anchored two years before, and found that the bottom of the sea had been raised more than eight feet.

November 19, 1822. The shock of an earthquake was felt along the coast of Chili for 1200 miles. —

When examined afterwards, the district about Valparaiso was found raised above its former level from 3 to 4 feet. The extent of country elevated embraced an area of 100,000 square miles.

June 16th, 1819. An earthquake at Cutch, in the delta of the Indus, was felt for 800 miles around. A deserted channel of the Indus was deepened some twelve or fifteen feet. Here we discover subsidence.

1811-12. *New Madrid Earthquake.*—Humboldt remarks in his *Cosmos*, that the great earthquake of the Mississippi Valley was remarkable for the incessant quaking of the ground for several months in succession, *far from any volcano*. Large lakes, twenty miles in extent, were formed in an hour, and others were drained. The graveyard at New Madrid was thrown into the Mississippi river, and the ground for fifteen or twenty miles up and down the river, sank eight feet below the former level. The earth rose in great waves—the soil burst, and large volumes of water, sand, and pit coal were discharged as high as the trees. Deep chasms were formed in a direction from S. W. to N. E. The Mississippi was arrested in its course and flowed up stream. The effects of this earthquake were felt for about 80 miles North and South, and 30 miles East and West. The whole region of country is commonly called the “sunk country.”

Numerous fissures still remain, but they are fast filling up, and judging from the past, all visible effects will very soon be erased. The depression remains as the permanent effect; but, to the stranger's eye, this would not be apparent.

In reflecting upon the earthquakes of the last forty years, Mr. Lyell says, "New rocks have arisen from the waters; new hot springs have burst out; and the temperature of others has been raised; the coast of Chili has been thrice permanently raised; a considerable tract in the delta of the Indus has been sunk down, and some of its shallow channels have become navigable; part of the great plain of the Mississippi for a distance of eighty miles in length by thirty in breadth has sunk down several feet; the town of Torobroo has been submerged, and twelve thousand of the inhabitants of Sumbawa have been destroyed. How then can the geologist declare that the earth has settled into a state of repose? How can he still affirm that the changes of relative level of land and sea so common in former ages of the world, have now ceased?"

3. *Gradual Elevation and Depression or Upheaval and Subsidence* without volcanos and earthquakes.

The coast of Sweden has been gradually rising for many years past; an extent of more than a thousand miles. The breadth of tract subject to eleva-

tion cannot be accurately determined, but it is believed to extend far into the interior both of Sweden and Finland. The rate of elevation appears to be about four feet to the century. On the other hand, the western coast of Greenland has been subsiding for the last four centuries. The Moravian settlers there have moved their poles on which their boats were set, and the old poles remain beneath the water.

The causes of these slow, silent movements of upheaval and subsidence may be found in the expansion of matter by heat, the accumulation of gases, or the crystallization of fluid. *Heat* acting in some form, or probably in various forms, seems to be the principal agent.

5. *Fifth Dynamic Agent. Chemical action.*—The laws of chemical affinity, to which we have alluded in a former section, have been operating ever since the dawn of creation.

Take an evening walk along a shady creek; pick up a fragment of common limestone which has been washed down from some neighboring hill. Examine it. Apply an acid to it. You find it to be composed of carbonic acid and lime. Look at its fossils and you find it to be one of the oldest of the stratified rocks. Now answer this question—How was it formed? Did the Creator make it in a

moment, or did he first create its elements and then combine them by the everlasting laws of chemical affinity? We believe the latter. To believe any thing else would force us to the adoption of an absurdity,—in other words, to say that there was a time when God formed a compound substance without uniting together its elements in definite proportion, although the compound is found upon strict analysis to consist of these elements.

Chemical law, contemplated as an abstract principle, is just as ancient and immutable as moral law. They both emanate from the infinite mind of the Eternal One. They both commenced actual operation at the time appointed,—the one, when Creative Wisdom had by miraculous power brought into existence the elements of the globe,—the other, when the same Creative Wisdom had, by the same or similar miraculous power, brought into existence a moral agent.

Taking this view of the subject, we are brought to the contemplation of one of the most wonderful agents which the Supreme Being has appointed for building up the great solid masonry of man's habitation.

Let us examine it a little further.

Look at the Granite Hills—physical monuments of their Creator's power. They make up a large

portion of the crust of our globe, forming a deep foundation for a fine superstructure. Now, after you have indulged your taste for the beautiful and sublime, — after “a flow of soul,” — sit down for a few moments to “a feast of reason.” Break off a piece of that granite. Examine it cautiously. It is composed of *quartz*, *mica*, and *feldspar*. But each one of these is a compound body. *Quartz* is the *oxide* of *silicon*. *Mica* is a compound of silex, alumine, potash, peroxyd of iron, fluoric acid and water; and each one of these materials is a compound substance.

Feldspar is a compound of silex, alumine, and potash, in proportions differing from those of mica.

Suppose we look at the quartz. Was there ever a time when quartz was not oxide of silicon? No. How is oxide of silicon formed? By the union of oxygen and silicon. Can it be formed by the union of any other elements, or without any union at all? No. What! not by the Almighty himself? No, not by the Almighty himself, for the obvious reason that before he formed it he decreed that he would — and in that one way. He will not violate his decree.

In like manner the Almighty has decreed “the soul that sinneth, shall die.” It is morally impossible for him to revoke the edict. The God of Nature is the God of Grace. In both systems are

found law and order;—in both—miracle,—but not in a single instance can we discover that miracle is a violation of law or order.

Again, look at the structure of the Allegheny mountains—massive limestone, sandstone, and coal, formed and deposited in order during many successive centuries. What part did chemical action take in building up this part of the earth? Why, very plainly, carbonic acid was continually at work seeking a union with the oxide of calcium, or lime, and by the association *carbonate of lime* was formed. Silica, and alumina, and iron combined their forces, and immense layers of *sandstone* were formed. And carbon, and silica, and alumina, and iron united, all under the command of the great Builder, and the result of their combination was an inexhaustible accumulation of *coal*.

The reader may easily extend the inquiry. We must proceed to another branch of the subject.

It is believed by a number of geologists that the intense heat of the interior of the earth is owing, not to igneous fusion of the central parts, but “to chemical changes constantly going on in the earth’s crust; for the general effect of chemical combination is the evolution of heat and electricity, which in their turn become sources of new chemical changes.”

Such is the opinion of Mr. Lyell; and he has devoted several chapters of his large work on the "Principles of Geology" to the defence of this theory. Instead of receiving the old and still popular doctrine concerning volcanoes and earthquakes, he adopts the chemical theory. We quote two or three passages from his work.

"It is admitted that intense heat would be produced by the occasional contact of water with metallic bases; and it is certain that during the process of saturation vast volumes of hydrogen must be evolved. The hydrogen thus generated might permeate the crust of the earth in different directions, and become stored up for ages in fissures and caverns, sometimes in a liquid form, under the necessary pressure. Whenever this gas would come in contact with metallic oxides at a high temperature, the reduction of these oxides would be the result.

"No theory seems at first more startling than that which represents water as affording an inexhaustible supply of fuel to the volcanic fires; yet it is by no means visionary. Many volcanoes are submarine, and the remainder for the most part occur in islands and maritime tracts.

"The most probable cause of volcanoes and earthquakes, then, is to be found in the liquefaction of

rocks, and the generation of gases by the chemical action of water upon metallic bases. The expansive and explosive power of gases is adequate to the ejection of lava."

6. *Sixth Dynamic Agent. Vital Action.* — The agency of life, manifested in all the forms of vegetable and animal existence, and throughout all the periods of the past history of the globe, is a problem which requires for its solution a knowledge of plants and animals, living and extinct—their history, habits, and habitations, and their multiform relations, one to another, and to the inorganic world.

The number of species of living plants is not far from 100,000. The number of species of living animals has been estimated at 250,000.

The distribution of plants and animals upon the surface of the earth is regulated by climate. This is true of all animals except man. Being lord of the inferior animals, he lives everywhere.

Naturalists have divided the globe into climatal regions or zones, and every region has its species.

The trees and plants peculiar or indigenous to a certain region constitute the *Flora* of that region.

The animals indigenous to a country constitute its *Fauna*.

Thus we have the Arctic flora and the Arctic fauna; the Asiatic flora and fauna; the African, the

Malayan, the North American, the South American. Wherever the plants and animals of a large extent of country—a continent, for example—are different in form, size, species, and climatic peculiarities, they should be arranged in separate flora and fauna. For instance, a Brazilian flora and fauna would be different from those of Patagonia.

Every age of the earth's existence has had its *fauna* and *flora*. The Creator has introduced new species, and fixed their habitations, age after age, until the last great work was performed—the creation of Man. Since then, we believe, no species has been created, though some of our modern physiologists think to the contrary.

Now this vast array of vegetable and animal being presents a great *life-power*, which has contributed large donations to the upbuilding of the world we inhabit.

Had there been no vegetation during the coal epoch, we should have had no coal—at least no such bituminous fuel as we now have.

The siliceous shields of infusoria compose the tri-poli of commerce.

The calcareous covering of molluscos animals affords material in part for the vast deposits of limestone.

But, greater than all, the labors of the coral ani-

mal afford a most astonishing example of the agency of organized beings in contributing to the increase of the solid matters of our globe.

The coral zoophyte varies in size from a grain of mustard-seed to a plum. The substance called coral is an internal skeleton, and not a collection of cells. It is formed by an organic action, or vital process, and not by instinct. They take the limy water from the ocean and convert it into limestone. They propagate their species by eggs and buds. They usually live in masses of hundreds of thousands, though sometimes they are found alone. They have mouths and stomachs, and possess the senses of touch and taste. When associated in myriads they eat and digest separately, but combine their labor, if we may so speak, in the construction of a common skeleton. The vital action of the whole group is concentrated upon the growth of the calcareous mass, which increases with such astonishing rapidity, and presents so many forms of strength and beauty, that man, with all his skill as an architect, stands amazed at the structure.

The great coral reef of New Holland is more than one thousand miles in length. The Pacific Ocean is almost crowded with coral islands, and the Red Sea is fast filling up, and becoming every year less and less navigable.

The investigations of the naturalists of the United States Exploring Expedition show plainly that coral reefs are of three kinds: viz., *Fringing*, *Barrier*, and *Circular*.

Fringing reefs are borders of coral extended out from coasts from fifty to a hundred feet.

Barrier reefs stand out from the coast, and are separated from it by a channel.

Circular reefs are formed in such a way that they enclose a circular or elliptical pool of water, called a *lagoon*.

Coral islands are subject to subsidence and upheaval. A fringing reef often sinks in the ocean, and afterwards grows up and reappears as a barrier reef. This upward growth, however, is not upheaval. It requires the volcano, or the expansive power of subterranean heat, similar in its movement to a volcano or earthquake, to heave up the island, and put it far above the ocean level.

After growing up to the surface of the sea, coral islands accumulate sand, calcareous matter, vegetable matter, weeds, drift, etc.; and bye-and-bye soil is made, seeds are brought by ocean currents and birds, and the reef becomes habitable land.

Such are the wonderful acts of these radiated animals; and thus have they been performing their

part in adding material to the earth, and man has had an opportunity of watching their evolutions.

But the story is not half told—indeed, we have barely commenced it. We must give it in parcels, in the chapters on the different formations, remarking here, in conclusion of this section, that the coral animal has been a workman under the guidance of the Supreme Architect ever since the deep foundations of the earth were laid. We find specimens of his work throughout all the rocky strata of the earth, from the oldest stratified deposits to the very latest.

7. *Seventh Agent. Death.*—Death is a benevolent institution. The history of man and all the animals under him clearly proves this truth. So, likewise, the history of the globe before the creation of man plainly demonstrates that the death of organized beings was devised in infinite wisdom and consummate goodness.

The scriptural truths concerning death relate to the human family. The introduction of animal and vegetable death prior to man's creation is a part of the Divine arrangement for animal enjoyment and human happiness; and the subject is not set forth in Revelation. It relates exclusively to present existence, and therefore does not come within the scope of inspired teaching.

The death of plants is absolutely necessary, to prevent exuberance of vegetation, to form important materials for soil, to repair waste places of the earth's surface, and to give to the rivers, the lakes, and the seas the drift which, borne off from a thousand forests, passes down to the universal funeral of living forms.

The death of animals, regarded merely as a temporal arrangement, is one of the richest provisions of goodness. In this respect, death has reigned from the Trilobite to the Mastodon, from the Mastodon to Man; and everywhere, and in every age, it has been the same conservative-power.

In the language of Roget, "The ordinance has been issued to a large portion of the animal world, that they are to maintain themselves by preying upon other animals—either consuming their substance when already dead, or depriving them of life in order to prolong their own."

Animals below man, as well as man himself, die naturally or by violence. Both forms among the inferior animals prevent too great an accumulation of beings. They are "checks and balances" in natural government.

One step further. When deprived of life, their remains are committed to the great burial-place of the dead—the *earth*—some upon land, and some in

the water; and there they rest, to await the changes appointed by Omniscience.

The death of the animal subjects it to chemical change, or decomposition. The corruptible part is resolved into elements which go back to earth, and air, and water. The durable part becomes fossilized, and myriads of fossil bodies lie entombed in all parts of the earth, testifying that death is a part of

“One stupendous whole,”

in the economy of nature as well as grace.

This is the “Thanatopsis” of the geologist. The theologian looks further. It is not our province to intrude upon the Christian doctrine of death as taught in the Bible. That is a matter of Revelation. This of which we now speak is a matter of human discovery — one of the appointments of the God of Nature.

The Combined Action of these seven Agents. — All great effects proceed from a combination of causes. A variety of means must be employed to arrive at a certain end. The house-builder employs a variety of agents and a variety of materials to build a house. “He who has built all things” has pursued a similar course in preparing a habitation for the human family. After creating material, and fixing physical law, the work of law commenced. All the

agents of which we have been speaking commenced their respective functions in due time, and all have been "*working together*" for the good of man and the glory of the Creator.

The atmospheric and aqueous agents which we have described are usually considered *Degrading Causes*.

The igneous and organic agents are described as *Elevating Causes*.

The former wear down the land, the latter elevate it.

It would be better, perhaps, to distribute the whole into three classes: viz., *Degrading, Accumulating, and Elevating*.

Water degrades land at one place and accumulates it at another. Vital action is accumulative; igneous action elevating

Let us make out a supposable case. The Mississippi River has been running for many years past, and we have reason to believe it will run for many years to come. During the historical period,—that is, since man was created,—it has borne to the Gulf of Mexico some twenty-five trillions of cubic feet of solid mineral matter, together with shells and other animal and vegetable remains. It has conveyed it all very safely, and deposited it at the bottom of the Gulf; and there, by pressure, it has be-

come—or rather is becoming—consolidated. Hence it is accumulating. Bye-and-bye, in the course of ages, violent volcanic action, or slow and imperceptible upheaving movement, caused, probably, by internal heat, will bring up a large island—a second Cuba—for contending nations to quarrel about.

The coral may go to work and build up, and unite, and annex, and “toil on in the treacherous main,” and wind, and waves, and currents may bring the drift, and the sands, and the seeds, and in less than 100,000 years the Gulf of Mexico will be “nowhere,” and North and South America united.

There is an everlasting circulation of land as well as water. The degradation of the Rocky Mountains is the enlargement of the American Archipelago.

Uniformity of Principle. Intensity of Action. The School of Lyell and the School of Murchison.—There is some difference of opinion among geologists with regard to the manner in which all of these great agents have acted during the former conditions of our globe. Mr. Lyell contends that at no period of the history of our earth have any or all of these causes operated with greater intensity than at present; and it must be admitted that he defends his theory with singular ability. He sees no reason for supposing that there have been sudden and powerful

upheavings, such as would make a mountain-chain in a short time; but that all things have moved on much upon the present plan. True, there have been sudden risings and fallings, as now, during earthquakes—tremendous volcanic action, as during the human epoch; but nothing more. All that is wanted is *time*.

In a philosophical point of view, Mr. L.'s views are regarded as tenable; but we believe that most geologists, perhaps more than nine-tenths, do not fully agree with him. While, in the main, he may be correct in affirming the slow and quiet procession of the dynamic agents that have worked out the multiform changes we discover, still it is thought there are many demonstrations on our earth of "extraordinary violence," occurring more especially at the introduction of new epochs.

On this subject Mr. Murchison has the following remarks:

"The uniformitarian, who would explain every natural event in the earliest periods by reference to the existing conditions of being, is stopped at the threshold of the palace of former life, which he cannot deprive of its true foundations. Nature herself, in short, tells him, through her most ancient movements, that, though she has worked during all ages on the same general principles of destruction

and renovation of the surface, there was formerly a distribution of land in reference to the sea, very different in outline from that which now prevails. That primeval state was followed by outbursts of great volumes of igneous matter from the interior, the extraordinary violence of which is made manifest by clear evidences.

“Fractures in the crust of the earth, accompanied by oscillations that suddenly displaced masses to thousands of feet above or beneath their previous levels, were necessarily productive of such translations of water as to abrade and destroy solid materials to an extent infinitely surpassing any change of which the historical era affords an example.”—*Siluria*, p. 476.

Here, then, is the difference, and at the same time the agreement:

Mr. Lyell believes,

1. That fire and water are the principal agents in the revolutions of our globe.

2. That they have acted always slowly and silently (except as in modern volcanoes) through countless ages.

Mr. Murchison believes the same thing of fire and water.

Mr. M. believes that these agents have acted *slowly and silently* through indefinite ages—and also occasionally in a sudden and strenuous manner, unlike anything of modern times.

P A R T II.

CLASSIFICATION OF ROCKS.

**GENERAL VIEW OF FOSSILS. LIVING AGES OF
THE GLOBE. DESCRIPTION OF THE
DIFFERENT FORMATIONS.**

(117)

CHAPTER VI.

Classification of Rocks.

THERE are three great classes of rocks, **IGNEOUS**, **AQUEOUS**, and **aqueo-igneous**. The first have their origin in *fire*, the second in *water*, and the third in both.

After a careful examination of several methods presented by authors for the arrangement of rocks, I have adopted the following, which is given in tabular form.

Table Exhibiting the Classification of Rocks.

1. Igneous Rocks.	{	A. Plutonic.	{	Granite, Syenite, Hornblende, Pegmatite, etc. etc. etc.
		B. Volcanic.		Trap, Basalt, Amygdaloid, Pumice, Breccia, Greenstone, Obsidian, etc. etc. etc.

These rocks are *unstratified*.

2. Aqueous Rocks.	These only are Fossiliferous.	1. Alluvial.—Gravel, Loam and Sand. 2. Diluvial.—Drift, Boulders. 3. Tertiary.—Eocene, Miocene, Pliocene. 4. Cretaceous. — Chalk, Greensand, Gault. 5. Wealden. 6. Oolite.—Upper, Middle, and Lower. 7. Lias. 8. New Red Sandstone. 9. Coal. } Carboniferous 10. Mt. Limestone. } formation. 11. Old Red Sandstone. 12. Silurian. 13. Cambrian.
3. Aqueo-Igneous.		Called { Gneiss, Statuary Marble, Clay Slate, Mica Metamorphic. { Slate, Hornblende Slate, etc. etc.

These rocks, of the second and third class, are *stratified*.

Considered in reference to organic remains, rocks are either *fossiliferous* or *non-fossiliferous*, and when arranged in reference to the primeval absence of life and the subsequent development and diffusion of living forms, they have been named as follows:

1. *Azoic Rocks*, including all destitute of organic forms, such as the plutonic, volcanic, and metamorphic.

2. *Zoic Rocks*, including the palæozoic, mezozoic, and kainozoic.

SECTION 1. *Of the Azoic Rocks*.—The term *azoic* means without life. Azoic rocks are all those rocks

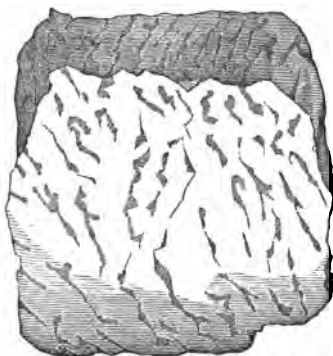
in which no living form, whether vegetable or animal, can be found.

They are *plutonic*, *volcanic*, and *metamorphic*. The *plutonic rocks* embrace all the varieties of *granite*, coarse and fine; syenite, schorl rock, eurite and pegmatite, graphic granite and porphyritic granite.

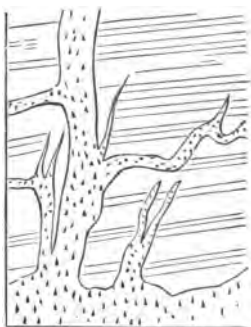
Granite is composed of quartz, mica, and feldspar, and frequently contains mineral substances in crystalline form, such as garnet.

It is found of every color; red, black, yellowish, light, grey, etc. Grey granite is the most common. When it contains well-marked crystals of feldspar it is called *porphyritic granite*.

When the crystals of quartz are dark-colored and penetrate the feldspar, so that when a fragment is broken at right angles to these crystals, it presents a surface somewhat like the Hebrew letters on a piece of paper. This variety is called *graphic granite*.



Granite is often found in veins traversing other rocks, such as clay slate, gneiss, etc.



Granite veins traversing clay slate.

Syenite. — When hornblende is the substitute for mica, the rock is called syenite, named after Syene in Egypt, where it was extensively quarried.

The quadruple compound of quartz, mica, feldspar, and hornblende, has been named syenite granite.

Schorl rock is an aggregation of tourmaline and quartz.

Granite and all its plutonic associates must not be regarded of one age. These rocks are of all ages. Granite, for example, underlies the stratified rocks, and there it is *primary* and *ante fossiliferous*; but when we find it associated with the stratified rocks in such a manner as to indicate that it is a cotemporary, it is not proper to regard it as primary.

The same may be said of all the granitoid rocks.

Volcanic Rocks.—Volcanic rocks are of all ages, and they embrace a great variety of names, although the mineral substances contained in them, when analyzed, are found to contain only some eight proximate elements or metallic oxides, viz.: silex, alumine, magnesia, lime, potash, soda, oxide of iron and manganese.

Our best text-books describe about fifty different volcanic rocks. We will give an alphabetical list of some of the most prominent, leaving the reader to search further for himself, if he feels disposed to do so.

Amygdaloid.—Any rock in which round or *almond-shaped* nodules of some mineral, such as agate, calcedony, calcareous spar, are scattered through a base of basalt, greenstone, or other kind of trap.

Augite Rock.—A kind of basalt or greenstone, composed of granular augite. Augite is composed of silex, magnesia, lime, and iron.

Basalt.—A mixture of augite and feldspar, with magnetic iron, alumine, etc.

Claystone.—A compact stone of purplish color, like an indurated clay, containing crystals of quartz.

Clinkstone.—A greenish or grayish rock, composed of compact feldspar, disposed to divide into slabs.

Diorite. — A kind of greenstone.

Greenstone. — Composed of hornblende and feldspar.

Hornblende is composed of silex, alumine, magnesia, lime, oxide of iron, and a trace of manganese. Feldspar is composed of silex, alumine, lime, potash, and a trace of iron.

Greystone. — Grey and greenish rock, composed of feldspar and augite — mostly the former.

Hypersthene Rock. — A mixture of Labrador feldspar and hypersthene, looking like granite.

Hypersthene is composed of silex, alumine, magnesia, lime, and oxide of iron.

Leterite. — A red, jaspery rock, composed of silicate of alumine and oxide of iron.

Lava. — Any melted matter flowing from a volcano.

Obsidian. — Vitreous lava, like melted glass.

Ophite. — A green porphyritic rock, composed chiefly of hornblende.

Pearlstone. — A rock having the lustre of mother-of-pearl, something like obsidian.

Pitchstone. — Vitreous lava, less glossy than obsidian — has the appearance of pitch — composed of feldspar and augite.

Porphyry. — Any rock in which detached crystals of feldspar are diffused through a base.

Pumice. — A light, spongy, fibrous form of trachyte.

Scoriæ. — Volcanic cinders.

Serpentine.—A greenish rock, containing much magnesia.

Toadstone.—A kind of wacke.

Traptuff.—Fragments of scoriæ and pumice, accumulating about volcanoes, and mingling with shells and other rocks, etc., form step-like prominences. Hence this name.

Trachyte.—A porphyritic rock, composed of glossy feldspar, containing crystals of the same.

Trass.—Mud poured out by lake craters.

Wacke.—An earthy variety of trass, resembling indurated clay.

A chemical analysis of these volcanic rocks, or all of them in every possible variety, will show that they are compounds of various proportions of silex, alumine, magnesia, potash, soda, iron, or manganese.

Metamorphic Rocks.—These are the stratified crystalline rocks, and, as the name implies, they have undergone a change. In plainer language, they were originally deposited from water, as sediment, and have been altered since by subterranean heat, so as to assume a new form.

They are known by the following names: viz., *Gneiss, Mica Schist, Clay Slate, Chlorite Schist, Primitive Marble*, etc.

They have no organic remains, and are as crystal-

line as granite, yet divided off into beds. Hence they are called sedimentary.

Many fossiliferous rocks have, doubtless, in the course of ages, become metaphoric.

We here give a picture of gneiss. Any one may discover in a moment that it is stratified granite.



Gneiss. A Metamorphic Rock.

It must be borne in mind that all these igneous and aqueo-igneous rocks were not formed at once, and before the aqueous deposits. This is a mistake. We find Plutonic, volcanic, and metamorphic rocks formed in all periods. They are first, middle, and last.

SECTION 2. *Of the Zoic or Fossiliferous Rocks.*—Zoic rocks are all those that exhibit traces of life, whether vegetable or animal; and they are likewise styled fossiliferous (*fossil*, bearing) and sedimentary; being sediment deposited from water, and afterwards consolidated.

We have already shown how these depositions are

made. We will now state the mineral composition of the stratified rocks, their relative order of position, and their relative ages. We shall then be prepared to enter upon the consideration of a very important branch of our subject—the *Doctrine of Fossils*.

A rock, in the language of a geologist, is any mineral substance formed by nature; whether it be clay, iron, coal, limestone, or granite.

We have seen that the igneous rocks are crystalline and silicious.

The fossiliferous rocks may, in reference to their mineral structure, be distributed into three kinds: viz., silicious, argillaceous, and calcareous, with their several mixtures, such as silico-calcareous, silico-argillaceous, and calcareo-argillaceous.

The silicious rocks are the sandstones and flints; the argillaceous are the aluminous slates, etc., and the calcareous are the common limestones, composed of carbonic acid and lime.

The Silicious Rocks are found in great variety. The vast sand-pits and gravel-beds all over the earth present two forms. Compact sandstone, varying in thickness from two inches to twenty, affords another style, millstone *grit* is another, and *conglomerate*, or pudding-stone, is still another.

Silicious rocks are not confined to any one particular locality, nor do they seem to predominate in any particular formation of the crust of the globe; but they are diffused throughout the whole, from the Cambrian formation at the base up to the alluvial at the very top.

Argillaceous Rocks are also found diffused throughout all the formations. *Pipe-clay*, yellow loamy clay, *shale*, or slaty-like rock, found in large beds, and the fine *kaolin*, or porcelain clay, constitute the principal varieties.

Calcareous Rocks are likewise entitled to the privilege of universality. There is no one exclusive limestone formation; for limestone rocks, from one inch to two, and even three feet thick, may be found in all the formations—more especially, however, in its compact form—in the older deposits, such as Silurian and carboniferous.

Limestone is quite a large family. There is *Iceland spar*, a magnificent crystalline form, which shows double refraction; *Satin spar*, a fine fibrous variety, occurring in veins; *Chalk*, the well-known white earthy substance, which sometimes forms mountain-beds; *Calcareous tufa*, or *Travertine*, formed by deposition from waters around sticks, leaves, etc., porous and light; *Stalactite* and *Stalagmite*, cavernous

formations, the former pendant, the latter sessile; *Oolite*, consisting of small grains like the spawn of a fish; and *Compact limestone*, found in cliffs, and bluffs, and hills, and mountains all over the world, and used for building.

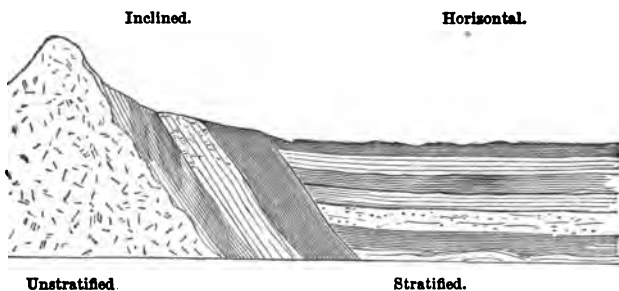
All these varieties can be easily scratched with a knife, and they effervesce with acids.

"Any limestone which is sufficiently hard to take a fine polish is called *Marble*. Many of these are fossiliferous; but statuary marble, which is also called saccharine limestone, is devoid of fossils, and a member of the metamorphic series."

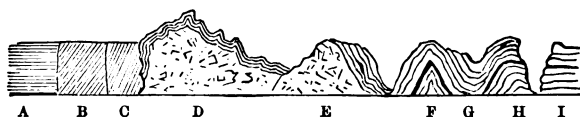
The three different kinds thus briefly described run into each other very frequently. Thus we have *silicious limestone*, a mixture of carbonate of lime and silex, harder than pure limestone; *bastard limestone*, in which aluminous matter predominates; *loam*, a combination of sand and clay, and *marl*, a combination of clay and carbonate of lime.

In addition to these, we may here mention two others, viz.: *magnesian limestone*, a compound of carbonate of lime and magnesia, and *gypsum*, composed of sulphuric acid, lime and water.

Stratification.—The following picture represents a section of the earth's crust, exhibiting the appearance of stratified and unstratified rocks.



Stratification is presented in several forms.



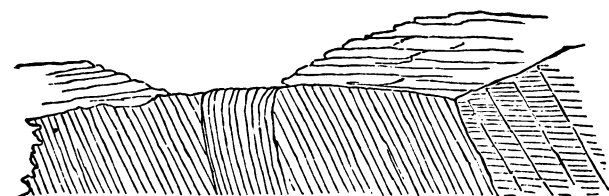
When strata lie in a level position they are called *horizontal*, as at A; when they slant they are said to be *inclined*, and the angle they form with the horizon is called the *dip*; when highly inclined they are called *vertical*, as at C; when bent and twisted they are called *contorted*, as at D. When suddenly thrown up, as by a volcano, they are said to be tilted up, as at E.

Strata dipping in two opposite directions from a ridge form an *anticlinal axis* or *saddle-back*, as at F.

Dipping to a common point, as at G, they form a *synclinal axis* or trough.

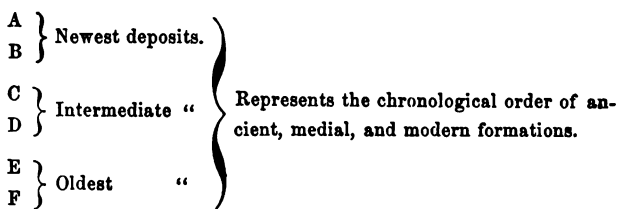
A bluff, as at H, is called an *escarpment*, and beds lying out from the course of strata to which they belong, are styled *outliers*. Where a stratum comes to the surface, it is said to *cropout* and the part is called the *outcrop*.

Strata are *conformable* when they are parallel to each other — *unconformable* when one form of strata lies over another form, as in the following figure, where the upper strata are horizontal, and the lower are inclined.

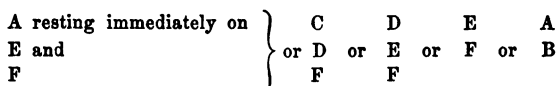


The various groups of fossiliferous rocks which constitute the greater part of the habitable world, are arranged in a regular order of superposition.

To illustrate this in general terms, we may take letters placed in vertical order. Thus the vertical arrangement:

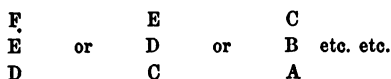


Now, some one or more of these may be absent in certain localities, and we often find such an arrangement as the following:



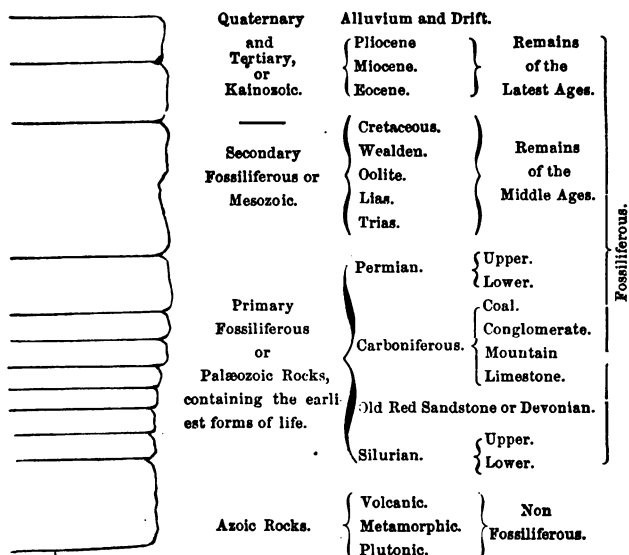
in which arrangements it must be observed, the top letter represents the surface formation or rock, and the letters beneath, the underlying formations as far as human hands have explored.

But we never find such an inverted condition as the following would present:



The following diagram shows the chronological order of the fossiliferous rocks represented as resting on the metamorphic and plutonic.

The existence of the two latter groups in the different ages of the zoic or fossiliferous deposits is not represented.



Such is the chronological order and relative position; but, as we have before said, strata are so distributed and arranged, that all of them appear in various parts of the world—here, as surface rocks—there beneath the surface. It may be said with truth, they all have a “fair showing;” and this exhibition of the various strata of the surface of the earth is made in order that man may have a “fair chance” to work his way through all of them.

If a traveller will start at Atlantic City in New Jersey, and travel westward, he will see this arrangement most beautifully displayed. For more than a

hundred miles he rides over the Atlantic plain. He starts on the middle tertiary, soon strikes the lower tertiary ; and, before he reaches the western extremity of the plain, he finds that he has entered the cretaceous. Then commences the Atlantic slope, and, from the cretaceous he steps right on to a metamorphic series consisting chiefly of gneiss, until, pursuing his journey westward, he reaches the great coal field of the Alleghanies.

CHAPTER VII.

General view of Fossils or Organic Remains.

WE have thus prepared the way for the most prominent topic of inquiry connected with geological research, and we ask the special attention of the reader while we endeavor to lay before him, in a systematic form, the leading facts and principles of this department of our favorite science.

We shall distribute our remarks on this subject into the following heads:

1st. *Definition.*—*Fossils are organic remains buried by natural causes.*

2d. *Fossils are petrified and non-petrified.*

3d. *Determination of fossils by comparison with living representatives.*

4th. *Fossils embrace, 1st, the grand divisions of the vegetable kingdom; and, 2d, the grand divisions of the animal kingdom.*

5th. *There is a preponderance of the radiated and molluscous animals in the palæozoic formations, and a gradual increase of higher animals up to the highest*

mammals, through the successive ages, until the appearance of man.

6th. *So, too, in the vegetable kingdom ; there is a preponderance of the inferior forms of vegetable life in the old or palæozoic rocks, and an increase of species and complication of structure, etc., throughout the ascending series.*

7th. *There was a cotemporary existence of the four grand divisions of the animal kingdom in the palæozoic formation ; and this cotemporary life is found throughout all the deposits, from the lowest to the highest.*

8th. *The doctrine of "development," as set forth in the "Vestiges of Creation," is not taught by the rocks.*

9th. *Every formation is characterized by its fossils.*

10th. *Fossils disclose the existence, perpetuation, decline, and extinction of successive races of animals, revealing vast periods of time preceding the age of man.*

11th. *The practical value of fossils in the exploration of strata is very great.*

12th. *The vast range of organic remains, both vegetable and animal, from the lowest sedimentary rock up to the modern surface, where the last of animate existence stands upright in physical perfection, develops a mighty plan, which must convince every reasonable being, guided by Revelation, that our highly-favored globe is the work of a wise and an omnipotent God.*

On the establishment of these twelve propositions

hang all the doctrines of geology, contemplated as a great collateral of natural history and of theology.

Let us proceed, then, to the examination of these, one by one.

SECTION 1. *Definition. Fossils are organic remains, buried by natural causes.* — Take a familiar illustration. You have often seen, in the vicinity of our cities, large quantities of bones, such as the skeletons of horses, cattle, hogs, etc. You have seen them, also, lying about in the country everywhere. You have seen shells of various descriptions lying on the banks of creeks, and about the gulfs and bays. You have seen them washed and rolled about from place to place, and presently you find a lot of them imbedded; or you have observed, perchance, the head of an ox, or a sheep, or the entire skeleton of an opossum, or a dog, perfectly imbedded in some little ravine or sand-bank. Now, suppose that thousands of thousands, and ten times thousands of years pass away, and the inhabitants of the earth at that future period to be walking and looking around; and, while making their observations, suppose they should happen to light upon certain very hard, mineral-like looking bones, or rock-like shells, and upon examination they should prove to be the vestiges of the several animals which you discover at this day. Place all this before your mind, and you

have a correct conception of a fossil. We may take an illustration from the vegetable kingdom. Go back, if you please, an indefinite time, and look at those beautiful palm-trees standing in South Carolina. They grow up, they fall, they become buried by the action of water; they subside slowly with the whole region, and then, after lying underneath an ocean for indefinite years, they emerge, and wait for the coming of man. You pass along in your rambles, stoop down, and gather up large pieces of petrified palm-wood. There is no mistake. It is the same palm that flourished in its living, verdant glory, ages ago.

It was an opinion entertained universally before the beginning of the sixteenth century, that all these fossils were generated by a "*plastic force*" of nature. Indeed, eminent men sat their wits to work, and conceived that a certain "*fatty matter*," set into fermentation by heat, gave birth to fossils; and as late as 1574, the opinion was entertained by educated Italians that "the fossil shells preserved by Pope Sixtus V. were mere stones, which had assumed their peculiar configuration from the influence of the heavenly bodies."

Is it not passing strange, then, that after all the light which has been thrown upon this matter within the last fifty years, there yet should be found

men, otherwise intelligent, who will contend that fossils are nothing but "freaks of nature." What a pity that, while pious in their feelings, and drilled in scholastic theology, they should deprive themselves of the glorious liberty of reading the great argument *engraved on stone* for the power, wisdom, and goodness of the everlasting God!

Let us examine it a little further.

Look at that rattlesnake. He is alive. Notice carefully his structure. It is adapted for *crawling*, *coiling*, *rattling*, and *striking*. Go on a little further. There lies a dead rattlesnake on the surface of the earth; the flesh is gone, and the skeleton remains. Tell me, what did he do when he was alive? Why, to be sure, he *crawled*, and *coiled*, and *rattled*, and *struck*. Why do you think so? Because his bony structure is similar to the live snake, which was seen to perform those evolutions. You reason well. Let us walk on a little further, and dig about in a bed of modern alluvium, and we come to the skeleton of a reptile imbedded in the heavy sand and loam. It is found, upon close examination, to be in every respect similar to the other skeleton, even to the rattle; and you pronounce it identical in species.

One step further. Look in that bluff bank, where workmen have been excavating to make a wharf for the populous city. Twenty feet below the surface

of the earth they find *that same snake*. Above the soil an oak-tree has grown, the age of which, as estimated by its rings, is 750 years. Now, will you say that is not the vestige of a rattlesnake—it is merely a freak of nature? No, no. It is a genuine fossil—the remains of a reptile embedded by natural causes.

Again. Go into your garden and examine the snails. Look how they crawl. See how they carry their calcareous house. Examine that mansion carefully. Now go again to that bluff, and find a large lot of snail-shells at the same distance of twenty feet from the surface. They are precisely similar to the shell of the living snail. And they have been there for ages. They once lived and moved. They died, and left their domicils behind them. Time rolled on. The floods came, and they were buried. Twenty feet of solid loam, with some mixture of compact sand, has been deposited upon them; and the big oak-tree, after all this, has grown until he is 750 years old.

Surely these are the organic remains of snails buried by natural causes. Concerning the remains of aquatic animals the explanation is still easier.

How is it that mountains, a mile thick, are filled with fossils? Just bear in mind that, “during the process of deposition, each separate layer was once

the uppermost, and covered immediately by the water in which the aquatic animals lived. Each stratum, in fact, however far it may now lie beneath the surface, was once in the state of loose sand or soft mud at the bottom of the sea, in which shells and other bodies easily became enveloped." Centuries have rolled away, and gradually the sand and mud has become compacted into solid rock; upheaval has brought the bottom to the top, and what was once the floor of the ocean has become the surface of the earth. We crack open the rocks and find entombed the remains of molluscos and other animals, who lived and died long, long before the earth was fit for the habitation of man.

SECTION 2. *Fossils are petrified and non-petrified.* — There is some confusion in the minds of many about the term petrification. Every petrification is a fossil, but every fossil is not a petrification.

All the fossils of the primary stratified rocks and the Secondary, and the tertiary in part, are in a state of petrification; but a large portion of the tertiary, all of the post tertiary and alluvial are non-petrified. Indeed, many of the shells of the tertiary beds which I have collected in the South, look very much like the common bleached bivalves of our water-courses, which have been laying out taking the sun for eight or ten years. Most of the bones,

if not all of our large extinct animals, such as the mastodon, are semi-petrified.

Petrifaction is a process which requires some explanation. The following, from Lyell's Elements, is as lucid as any I can find: "If an organic substance is exposed in the open air to the action of the sun and rain, it will in time petrify or be dissolved into its component elements, which consist chiefly of oxygen, hydrogen, and carbon. These will readily be absorbed by the atmosphere, or be washed away by rain, so that all vestiges of the animal or plant disappear. But if the same substances be submerged in water, they decompose more gradually; and if buried in the earth, still more slowly, as in the familiar examples of wooden piles or other buried timber. Now, if as fast as such particle is set free by petrification in a fluid or gaseous state, a particle equally minute of carbonate of lime, flint, or other mineral, is precipitated, we may imagine this inorganic matter to take the place just before left unoccupied by the organic molecule. In this manner a cast of the interior of certain vessels may first be taken, and afterwards the walls of the same may decay, and suffer a like transmutation. Yet, when the whole is lapidified, it may not form one whole homogeneous mass of stone or metal."

The natural process of petrification has been imi-

tated by the chemist in his laboratory. A variety of animal and vegetable substances has been steeped in waters holding in solution some silicious, and some calcareous matter. In a few weeks these organic bodies have become mineralized. It must be borne in mind that all the operations of nature are slower than the rapid experiments of the chemist. You can get up a dripping and percolating machine in a laboratory and form stalactites in a few days. The process in a cave may take twenty years. Hence we are not to infer, that because petrification can be forced in the lecture room for the instruction of students, the process may take place in a short time in the ocean, earth, or rivers. On the contrary, we know it to be a very slow process. Shells have been lying in river bluffs for more than a thousand years, (to mention as short a time as we need to admit,) and no petrification has yet taken place.

We have seen a few localities where petrification of wood has occurred in a comparatively short time, perhaps in the course of a generation, or a century; but these cases do not affect the general rule.

SECTION 3. *Determination of Fossils by comparison with living representatives.*

The habitation of animals has, in nearly all the ages of the globe, been, 1, the land, 2, the rivers or fresh

water, and 3, the ocean. Hence we have these three sorts of fossils, *land, fresh water, and marine*.

The first of these is not to be found in the oldest rocks, — hence we conclude there were no land animals at that early period.

Marine animals are the most ancient, such as corals, crablike crustaceans, and mollusks. They existed before any river was formed — before any stratified dry land had made its appearance.

Bye-and-bye rivers appeared, and in them, animals—adapted to fresh water existence; and when the land was fit for habitation — then land animals commenced their existence—all, doubtless by direct creation.

By comparing the organic remains imbedded in the various strata of the earth, with living animals—the geologist is enabled to determine with accuracy, the *class, order, genus, and species* of any fossil he may find. Thus, for example, you may gather up a great variety of handsome fossil corals from the falls of the Ohio, at Louisville, Kentucky, and compare them with the living corals of the Indian Ocean, or the Pacific. You cannot fail to see the resemblance. You may pick out of the rocks shells of all kinds, and when you have a hand-full, just put them down on a table, lay down by their side a parcel of sea-shells, and you must notice

some likeness. If then, upon a superficial examination of those shells, you arrive at the conclusion that they were once the houses of animals, may not the geologist, upon a close investigation, determine not merely the genus, class, order, and species, but describe the habits and instincts of the extinct animal.

Ascending higher in the scale of being, and approaching nearer modern times, we may glance for a moment at those huge skeletons which lie scattered about in various parts of the globe; sometimes near the surface, but oftener embedded in loam and gravel, several feet below.

There are the mastodons, elephants, elks, bisons, etc., found all over the United States and Europe. They lived long, long ago, and had undisputed possession of the country.

Their skeletons afford some clue to their character, even to the superficial observer; and we shall show, in another section, with what surprising accuracy the skilful anatomist can determine the habits and instincts of animals by an examination of their bones or other fossil remains.

A careful comparison of living with extinct forms, and of the more recent extinct forms with the more ancient, establishes a line of *congeners* (species of the

same genus), a sort of succession, reaching back to the earliest ages of animal and vegetable life.

By such comparison it is known that the mammoth, and the mastodon, and the extinct elephant were all *herbivorous animals*. Their teeth plainly indicate it. It is known that they were *mammals*, or milk-giving animals. Their teeth, and other points of anatomical structure, show this also. It is known that they were social in their habits, that they protected their offspring from attack by a most determined resistance, and that they never preyed upon smaller animals.

All these points can be determined with a small amount of careful observation and reasoning.

SECTION 4. *Fossils embrace, 1st, the grand divisions of the vegetable kingdom, and 2d, the grand divisions of the animal kingdom.*

1. *Of the Vegetable Kingdom.*—Botanists have divided the vegetable kingdom into two great divisions—*Phænogamous*, or flowering plants, and *Cryptogamous*, or flowerless plants.

Phænogamous plants have true flowers and seeds, having seed-leaves, called cotyledons, enveloping an embryo, or germ of a new plant. This division includes all the trees of our forests, all the flowers of our gardens, and the rich vegetation of the tro-

pical regions. It is divisible into two classes — the *Exogens* and *Endogens*.

Exogens, or outside growers, embrace all plants which have bark, wood, and pith; such as oaks, hickories, and the various forest trees of our country, together with beans, peas, etc., of the garden.

They are dicotyledons — that is, the seed is naturally divisible into two parts.

They grow by addition to the outside, — a new layer of woody matter being added every year, — and the age of the tree can be determined by counting the concentric rings.

They have also net-veined leaves.

They are divisible into angiosperms and gymnosperms.

Angiosperms bear their seeds in an ovary, or seed-vessel; as the oak, hickory, walnut, apple, pear, and peach.

Gymnosperms bear their seed inside of a scale; such as the pine, spruce, hemlock, cedar, balsam, yew, etc.

Endogens embrace all flowering plants which have no concentric rings, but a woody substance, disposed in bundles; as corn, wheat, rye, and all the grasses, palm, sugar-cane, and bamboo.

They have seeds which cannot be naturally di-

vided. The seed presents one whole grain; hence they are called *Monocotyledonous*.

Cryptogamous Plants bear no flowers, and produce no seeds; but something like flowers may be discerned, and they have spores for seeds.

They are divisible into three classes — *Acrogens*, *Anophytes*, and *Thallophytes*.

Acrogens embrace the *Ferns*, *Club-Mosses*, and *Horse-Tails*.

Anophytes embrace all the real mosses.

Thallophytes embrace the algæ, lichens, and fungi.

Vegetation has not been distributed from any one locality, but species have been created at different centres, and thence distributed; and in the bygone ages, new species were called into being at the introduction of a new age of life.

2. *Of the Animal Kingdom*.—Agassiz, the greatest zoologist living, has made some improvement on Cuvier in the arrangement of the animal kingdom. He divides the whole into *Branches* or *Types*, *Classes*, *Orders*, *Families*, *Genera*, and *Species*.

He says, "*Branches*, or *Types*, are characterized by the plan of structure.

"*Classes*, by the manner in which that plan is executed, as far as ways and means are concerned.

"*Orders*, by the degrees of complication of that structure.

"*Families*. by form.

“*Genera*, by the details of execution in special parts.

“*Species*, by the relations of individuals to one another, and to the world in which they live, as well as by the proportion of their parts, their ornamentation, etc.”

There are four great branches of the animal kingdom: viz., Radiates, Molluscs, Articulates, and Vertebrates.

Radiates comprise all animals who are constructed on the plan of radiation—that is, whose organs radiate from a common centre.

This branch embraces three classes: viz., *Polyps*, *Acalephs*, and *Echinoderms*.

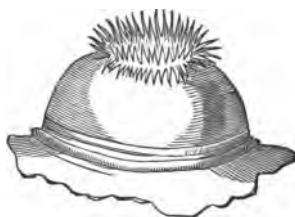
Polyps are all those animals which have a tubular or sack-like body, with a circular disc, having a mouth at the centre, and surrounded by tentacles. They all belong to the ocean; living on the coasts, and never extending their excursions further out than twenty fathoms. They are called zoophytes, from their close resemblance to plants. They range in size from a pin-head to a small watermelon.

They increase by eggs, by budding, and by dis-unions. Cut a polyp up into very small pieces, and each piece will become a new animal.

The sea anemone, or actinia, is a familiar illustration of this class of animals.



Closed.



Opening.



Full-blown.

Actinia, or Sea Anemone.

When closed, it looks like a boy's round-top hat ; when opening, like the same hat, having a small bunch of grass on the top ; and when fully opened, like the hat covered over with grass and flowers.

Another familiar illustration may be seen in the *corals*. Their name is legion, and their profession *architects*.

"Toil on, toil on! ye ephemeral train,
 Who build in the tossing and treacherous main;

Ye bind the deep with your secret zone,
 The ocean is sealed, and the surge a stone."

MRS. SIGOURNEY.

This is beautiful poetry; and, on the principle of poetic license, it is correct. But it must be remembered, as we have before stated, that the coral animal (not coral insect) neither *toils* nor *builds*. It secretes a living skeleton. It is an organic function just like the function performed by man in the secretion of his own bony frame. There is no skill or instinct in the operation. And while it is a *blind necessity* on the part of the coral, it is a display of infinite wisdom on the part of the Creator.

The beautiful coral reefs of the Pacific and Indian Oceans present to the eye a perfect ocean Paradise. All forms of trees, fruits, and flowers, mosses and ferns, rise up from the deep. The blind coral polyp, though not aware of it, is a magnificent ornamentalist.

The poet has expressed in two lines the office of this humble zoophyte —

"The sea-snatched isle is the home of man,
 And mountains exult where the wave hath been."

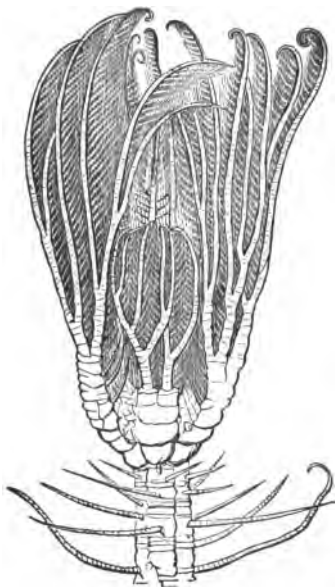
This is the answer to the question,

“Why do ye plant 'neath the billow dark
The wrecking reef for the gallant bark?”

Acalepha, nettle animals, embrace the Jelly fishes, etc. They have been divided into *Hydroids*, *Discophoræ*, and *Ctenophoræ*, all of them plant-like animals — a few inhabiting fresh water, but the larger part, the ocean.

Echinoderms embrace all those marine radiates which have calcareous coverings bearing spines.

Four orders have been described, viz. : *Crinoids*, *Asteroids*, *Echinoids*, and *Holothuroids*.



Pentacrinus Caput Medusæ. West Indies.

The *Crinoids* are those beautiful lily-like animals, attached by a stem to a rock, having a very limited locomotion. In the pre-Adamite periods they flourished largely, and their fossil forms are found in abundance in the oldest rocks. They are known generally by the name of *Encrinites* and *Pentramites*.

There is one living species of Crinoid, which may serve as a representative of the fossil forms. It is the *Pentacrinus Caput Medusæ*—so beautifully figured in Buckland. It is found in the West Indies.

The *Asteroids* comprise the Star-fishes—found living on our sea coasts; and, in a fossil state, abundantly in the tertiary formation.

The *Echinoids*, or Sea Urchins, resemble somewhat a chestnut-burr when its spines are adherent,—and a round pin-cushion with the pin-heads sticking out, when the spines are removed. Fossil forms of the Echinoideans are found from the liassic group of rocks upward to the modern deposits. They have a great variety of names.

Holothuroids are represented by sea slugs.

Let us pass on now to a notice of the next *branch*.

The *Molluscs*, or molluscous animals. These have soft bodies, “slippery and slimy,” like oysters and snails. Those that have shells are called *Testaceous*; those that have not, are called *naked*.

In reference to geological investigation, we can treat only of the *testaceous kinds*. The soft bodies decay and disappear in ultimate elements. The shells remain and become *fossilized*.

According to Agassiz, the number of living species is 16,000, and they are divided by him into three classes — *Acephals*, *Gasteropods*, and *Cephalopods*, embracing quite a number of subdivisions.

Acephals include the *Brachiopods*, *Tunicata*, *Lamellibranchiates*, and *Bryozoa*.

The most notable example of the *Brachiopod*, is the *Terebratula*, found on our sea coast, and found in all the formations of the earth, petrified in the oldest rocks, and non petrified in the more recent. The shell is bivalve — unequal, that is, one valve larger than the other. The valves are styled ventral or dorsal. The ventral valve is the larger, and contains a beak, through which the animal thrusts his *arm-foot* to attach it to some convenient body.

We shall speak now only of the *Lamellibranchiates* under this head. As the name indicates, they embrace all those molluscs which have lamellated gills or branchia. The oyster, the clam, the mussel, etc., belong to this order.

The *Gasteropods* move on a *fleshy foot*, and they embrace a larger number of shell-animals than any other order. Such are the snail, the trochus, the

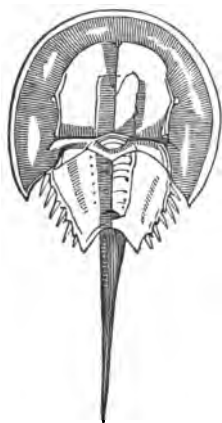
harpa, the voluta, the cassis or helmet, the murex, and the cypræa.

Gasteropods are found in great quantities in a fossil state.

Cephalapods—Head-footed molluscs—are all such as the nautilus.

The distinguished *Ammonite* is the great fossil representative of this class.

ARTICULATES embrace all animals whose bodies are divided into joints or articulations — as the spider and the fly. They have been estimated at 300,000. They are divided into three great classes viz.: *Worms*, *Crustaceans*, and *Insects*, and these are subdivided into genera and species.



Limulus.



Trilobite.

Crustaceans are represented by crabs, lobsters, shrimps, and crawfish.

The *Limulus* or Horse-shoe crab, belongs to a different class from the common crab, but they are both crustaceans. It is this *limulus* which geologists have selected as the best modern representative of the trilobite.

Insects embrace beetles, bees, bugs, butterflies, horseflies, grasshoppers, musquitoes, spiders, and scorpions.

VERTEBRATES embrace all animals which have a backbone consisting of a series of *vertebræ*. They all present two cavities—one for the brain and spinal marrow, the other for the organs of respiration, digestion, secretion, and reproduction.

It is divisible into four classes—*Mammals*, *Birds*, *Reptiles*, and *Fishes*. Professor Agassiz has added *Batrachians* (frogs) to the list, and thus makes five.

Mammals embrace all animals which nourish their young by milk. The species number about 2000. They are all warm-blooded.

They include, 1. *Man*; 2. *Monkey*; 3. the *Carnivora*, embracing the lion, tiger, cat, dog, otter, mink, seal, etc.

4. The *Ruminants*; embracing the ox, sheep, goat, giraffe, deer, moose, etc.

5. The *Rodents*, or gnawers; embracing the hare, squirrel, beaver, rat, etc.

6. The *Insectivora*, or insect-eating animals; as the bat, mole, hedgehog, etc.

7. The *Edentata*, or toothless animals; as the sloth, ant-eater, and armadillo.

8. The *Cetaceans*; as whales, porpoises, and dolphins.

9. The *Pachyderms*, or thick-skinned animals; as the horse, hippopotamus, rhinoceros, elephant, hog, and tapir.

10. The *Marsupials*, or pouched animals; as the opossum and kangaroo.

These ten orders are divided and subdivided, according to fixed principles of zoology, founded in nature.

Fossil mammals are not found below the late tertiary.

Birds embrace all animals which have wings and feathers. They are grouped in seven orders: viz.,

1. *Natatores*, or swimmers; as ducks, geese, and pelicans.

2. *Grallæ*, or waders; as herons, snipes, and flamingoes.

3. *Cursores*, or runners; as ostriches.

4. *Rasores*, or scratchers; as turkeys, hens, quails, etc., etc.

5. *Scansores*, or climbers; as woodpeckers and parrots.

6. *Insessores*, or perchers; as crows, jays, thrushes, and warblers.

7. *Raptores* or birds of prey; as eagles, hawks, owls, vultures, etc.

Number of species of birds, about 7000.

Reptiles embrace five orders: viz.,

1. *Rhizodonts*; large reptiles with hollow teeth.

2. *Saurians*; crocodiles, alligators, and lizards.

3. *Chelonians*; turtles — land, river, and sea.

4. *Ophidians*; snakes, of all sorts.

5. *Batrachians*; frogs and salamanders.

The number of living species of reptiles is 2000.

Reptiles are found as low down as the old red sandstone.

Fishes are divisible into four orders: viz.,

Placoids, *Ganoids*, *Ctenoids*, and *Cycloids*.

We here present the form of the scales.



Placoid.



Ganoid.



Ctenoid.



Cycloid.

Placoids embrace fish with flat scales and a cartilaginous skeleton. The scales have a curved spine. Such are the sharks and scates.

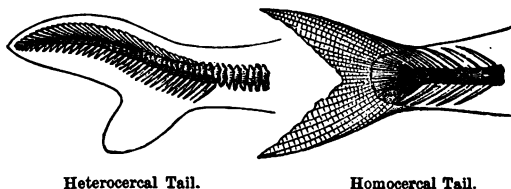
Ganoids are fishes having an enamelled scale, such as the sturgeon and garpike.

Ctenoids are fishes which have toothed scales; as the perch, bream, and bass.

Cycloids have rounded and entire scales; as the salmon, cod, mackerel, and trout.

Placoids and ganoids have heterocercal tails, or unequally bilobed.

Ctenoids and cycloids have homocercal tails, or equally bilobed.

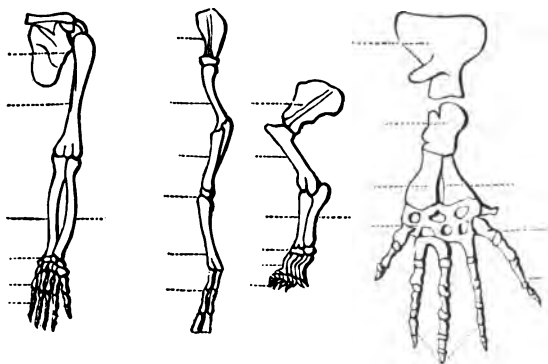


Placoids and ganoids are found in a fossil state in all the rocks. Comparatively few are found living.

On the other hand, ctenoids and cycloids did not make their appearance until the early tertiary deposit; and they now, in our times, constitute the large majority of fishes.

The following, from Agassiz and Gould's "Principles of Zoology," will show very clearly what is

meant by the homology of limbs — or the “*striking likeness*,” in an animal point of view, between man and his inferiors.

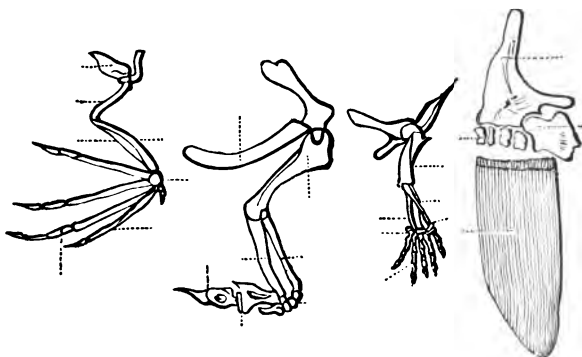


Arm of a Man.

Leg of a Deer.

Leg of a Lion.

Paddle of a Whale.



Wing of a Bat.

Wing of a Bird.

Leg of a Turtle.

Fin of a Fish.

SECTION 5. *There is a preponderance of the radiated and molluscous animals in the palæozoic formations,*

and a gradual increase of higher animals, up to the highest mammals, through the successive ages, until the appearance of man.

The following table, from Agassiz and Gould's "Principles of Zoology," will exhibit this at a glance.

	Radiates.	Molluscs.	Articulates.	Vertebrates.
	Polyps. Acalephs. Echinoderms.	Acephals. Gasteropods. Cephalopods.	Worms. Crustaceans. Insects.	Fishes. Batrachians. Reptiles. Birds. Mammals. —Man.
Alluvium and Drift...	-----	-----	-----	-----
Tertiary	-----	-----	-----	-----
Cretaceous	-----	-----	-----	-----
Oolitic	-----	-----	-----	-----
New Red Sandstone..	-----	-----	-----	-----
Carboniferous	-----	-----	-----	-----
Old Red Sandstone...	-----	-----	-----	-----
Silurian	-----	-----	-----	-----

SECTION 6. *So, too, in the vegetable kingdom, there is a preponderance of the inferior forms of vegetable life in the old palæozoic rocks, and an increase of species and complication of structure, etc., throughout the ascending series.*

The table on the next page, from Miller's "Testimony of the Rocks," will show this at a glance.

	Thallophytes.	Acrogens.	Gymnosperms.	Monocotyledons.	Dicotyledons.
Alluvium and Drift.....	-----	-----	-----	-----	-----
Tertiary.....	-----	-----	-----	-----	-----
Cretaceous	-----	-----	-----	-----	-----
Oolitic	-----	-----	-----	-----	-----
New Red Sandstone.....	-----	-----	-----	-----	-----
Carboniferous	-----	-----	-----	-----	-----
Old Red Sandstone	-----	-----	-----	-----	-----
Silurian	-----	-----	-----	-----	-----

SECTION 7th. *There was a cotemporary existence of the four grand divisions of the animal kingdom in the Palæozoic formation, and this cotemporary life is found throughout all the deposits from the lowest to the highest.*

The table under Section 5 will show this fact.

It was a favorite hypothesis of some of the old naturalists, and, indeed, some of our modern naturalists still contend for it, — that animal life began in a monad and progressed gradually upward—link by link, up to man.

The exhibition made by fossils, teaches us a different doctrine. In the lowest of the most ancient fossiliferous rocks we find the *trilobite*, a crustacean—an animal allied to the crab; and in the upper part

of this same ancient group of rocks we find the remains of some fishes.

In the next member of the palæozoic rocks (the Devonian) we find fishes in abundance; and associated with this class of vertebrates, we find crustaceans, molluscous animals, and radiates of different kinds.

The same remark is applicable to all the deposits above the Devonian, up to the very last; and now, during the historical period, or the Androzoic age, we find all forms of life, from the simplest to the most complicated, diffused throughout all parts of the globe. Animal life exhibits a net-work—not a chain.

SECTION 8. *The doctrine of “development,” as set forth in the “Vestiges of Creation,” is not taught by the rocks.*

What is the doctrine of development? It is a doctrine taught by Epicurus and his followers ages before Christ, revived by Lamark, the naturalist, in the beginning of the present century, and elaborated to some extent by Professor Oken, of Germany, and by the author of a work styled the “*Vestiges of Creation*,” who is an Englishman of wealth, taste, and talent; but rather given to fanciful and hasty generalization than to patient and accurate induction.

The doctrine is simply this. *Inorganic matter* was originally endowed with vital properties, by virtue of which, in connection with electricity, it was enabled to *develop* some feeble form of life, as a sea-weed, or an animalcule—the one a vegetable—the other an animal. This occurring in a thousand or ten thousand places, or even a million, would of course “make a right pretty start” towards the getting up of a vegetable and an animal kingdom. From the sea-weed is *developed* a flag—from the flag, a bush: from the bush a cedar-tree; from the cedar-tree, a dogwood; from the dogwood, a gum; and from the gum, an oak.

In like manner, electricity warming the vital particles of matter, hatches out a lot of invisible infusoria, and starts the world to kicking; and here, my reader, is our zoological succession,—*Monad, coral, starfish, crab, lobster, oyster, snake, lizard, frog, fish, bird, dog, hog, ox, monkey, man.*

Hugh Miller, the natural geologist, has given such an able refutation of the whole doctrine in all its bearings, physiological and moral, that nothing is left for us to do but to confirm his reasoning by further observation.

I cannot forbear the pleasure of making a lengthy quotation from the eleventh chapter of his *Foot-prints of the Creator*, in which the absurdity of the

principle is defended by a Lamarkian philosopher, and refuted by a plain English farmer.

After describing a submarine bed on the British coast, abounding in sea-weed and zoophytes, crabs and molluscs, he notices a stream that entered the sea, bearing down in flood-time remains of reptiles, earthy matter, and other things, which, sinking over the submarine bed, found a lodgment at the bottom. In the course of several thousand years the bottom came up to the top, by deposition from the stream, and sand thrown up by the sea, and it became a kind of marsh. Birds waded there, and a porpoise getting lost, died and was buried in and by the mud, silt, and water. Elevation going on gradually, the spot became a meadow, eight feet above the sea level, and then trees and shrubs grew upon it, and a fine, peaty mould was formed.

Bye-and-bye, an Italian boy came along with his monkey. The monkey died, and the boy buried him. Some years after, the corpse of a poor shipwrecked sailor was thrown up, and a herd boy covered it up close by the monkey. And, last of all, a farmer furrowed the flat meadow to the depth of some six or eight feet, by a broad ditch that laid open its organic contents from top to bottom.

Then came a Lamarkian philosopher and examined the section, and soon after him the farmer.

"I have been reading the history of creation in the side of your deep ditch," says the philosopher, "and find the record very complete. Look there," he adds—"there life both vegetable and animal first began. It began, struck by electricity, out of albumen as a congeries of minute globe-shaped atoms,—each a hollow sphere within a sphere, as in the well-known Chinese puzzle; and from these living atoms were all the higher forms of life progressively developed. *There* are fucoids, first born among vegetables,—and *there* are the zoophytes, well nigh the lowest of the animal forms. *There*, a few feet higher, we see the remains of reeds and flags into which the fucoids were developed; higher still we detect fragments of pine and juniper-trees and shrubs of the land, into which the flags and reeds were developed, and there in that peaty layer, immediately beneath the vegetable mould, there occur boughs and trunks of blackened oak, a noble tree of the dicotyledonous division—the highest to which vegetation has attained. Now, observe the progress of animal life. The zoophytes became crustaceans and molluscs,—the crustaceans and molluscs became dog-fishes and herrings—the dog-fish, a low placoid, shot up into turbot, cod, and ling; but the smaller osseous fish was gradually converted into a batrachian reptile;

in short, the herring became a frog. Gradually the herring passed into a warm-blooded porpoise; the porpoise, at length, tiring of the water as he began to know better, quitted it altogether, and became a monkey, and the monkey, by slow degrees, became a man. Such, sir, is the true history of creation as clearly recorded in the section of earth, moss, and silt, which you have so opportunely laid bare. Where that ditch now opens, the generations of the man atop lived, died, and were developed. *There* flourished and decayed his great, great, great, great-grandfather the sea-pen,—his great, great-grandfather, the mussel,—his great, great-grandfather, the herring,—his great-grandfather, the frog,—his grandfather, the porpoise,—and his father, the monkey. In like manner, sir, the majestic oak is a lineal descendant of the kelp-weed.”

“Master,” replies the farmer, “I see you are a scholar, and, I suspect, a wag. It would take a great deal of believing to believe all that. I am a plain man, but not quite a fool; and, as I have been looking about me in this neighborhood for the last forty years, I have come to know that it gives no assurance that any one thing grew out of any other thing because it chances to be found atop of it. See, yonder is Dobbin, lying lazily atop of his bundle of hay, and yonder, little Jack, with bridle in

hand, and he in a few minutes will be atop of Dobbin. And all I see in that ditch, sir, from top to bottom, is neither more nor less than a certain top-upon-bottom order of things. I see sets of bones and dead plants lying upon sets of bones and other dead plants, things lying upon top of things, as I say, like Dobbin on the hay, and Jack upon Dobbin. I doubt not the sea was once here, just as it was once where you see the low lying field yonder, which I won from it ten years ago. I have carted tangle and kelp-weed where I now cut clover and rye-grass, and have gathered periwinkles where I now see snails. But it is clean against experience, that it was the kelp-weed that became rye-grass, or that the periwinkles freshened into snails. The kelp-weed and periwinkles belong to those plants and animals of the sea that we find growing in *only* the sea, the rye-grass and snails to these plants and animals of the land that we find growing on *only* the land."

Let us, for a moment, look at the argument as it has been transmitted to us in this remarkable record—one antedating all others.

Place before you these three organic forms.

1. *Catenipora Escharoides*, (chain coral.)
2. *Spirifer Lynx*.
3. *A Trilobite*.

The first belongs to the radiate animals, the second to the molluscs, and the third to the articulate. Now, in all the existing seas and oceans of our earth, the representatives of these beings are widely separated from each other in their habits and functions. There is an impassable gulf between them. A modern madrepora can no more swim about and perform the evolutions of a king-crab, than a horse can ruminate like a cow. It has never risen above its instinct. No gradation can be traced between the two, which has any appearance of transmutation. Now if, in these last times, we can find no developing process linking one species with another, can it be possible that, in the very first ages of organic existence, a coral ever turned to a brachiopod, or a brachiopod to a crustacean? If, then, a monad never developed a coral, how, in the name of good sense, can matter develop a monad?

Again, if development (as taught by the school of Lamarck,) be an essential law of organized beings, what prevents *every crab* from passing into a fish, or every monkey into a man? There are yet millions of crabs, and millions of monkeys. Why don't they ALL develop?

Once more — Lamarckian, look here. Where is the necessity of sexual desire, or propagation of species by genital organs? There must certainly

be a constant supply on hand of newly developed beings, to take the place of those who have died.

Thus, for example, we need chimpanzees in Greenland and Labrador as well as in Africa, to keep humanity in operation. The fine stock farmer has no need of importing blooded horses, bulls, and rams. He may just wait for the development of a mule, an elk, and a he-goat. Indeed, there is no necessity for sex. The whole sexual system, from the house-fly up to man, is a most ridiculous humbug; and, notwithstanding the Sovereign of the universe said to blushing Mother Eve, "I will greatly multiply thy sorrow and thy conception; in sorrow thou shalt bring forth children, and thy desire shall be to thy husband," there has not, in reality, according to the development system, been any physiological necessity for any conception or bringing forth. Poor woman might save herself all this trouble—this vulgar business of giving birth to children and then raising them—just bring on the monkeys and let them develop.

Look, too, at the moral consequences. No father—no mother—brother, sister—no kindred ties—no genealogy among men—no promised seed of Abraham to bless the nations of the earth.

In a few words, then, the doctrine of development of one species from another, is contradicted by the

facts of all living nature. Metamorphosis, as exhibited in insects and frogs, is a phenomenon which consists in a change of form and function in the same animal—a change from one stage of life to another. It obtains, in various phases, throughout the animal kingdom, as Agassiz and others have demonstrated; but transmutation of species exists only in the disordered brain of an enthusiast.

It is contradicted by all the records of the pre-Adamite ages. In the upper portion of the lowest fossiliferous rocks we find the spines of fishes, *vertebrated animals*, which had a cotemporary existence with crustaceans and zoophytes.

It contradicts revelation, which assures us that God created man in his own image, and offers us the bestial speculation that Sir Isaac Newton, Benjamin Franklin, and George Washington, were all the descendants of a being whose illustrious predecessor was a howling monkey or ring-nosed baboon.

It robs God of creative power, and transfers it to electricity and cellular tissue; it robs him of wisdom, and gives it to globular vescicles; it robs him of goodness, and hands it over to primordial atoms. And thus developing one thing from another, it reaches the last stage of its development—the hypothesis of the man who says in his heart, "*There is no God.*"

On the contrary, how ennobling is the true doctrine! All species had a beginning. They received life from a life-giving power, and that power was God. Sound reason cries out for a first cause, and revelation satisfies the longing of reason. Here, in the commencement of life,—the very dawn of sentient existence, we have proof of distinct acts of creation—the creation of species.

SECTION 9. *Every formation is characterized by its fossils.*

The severe labors of European and American geologists have enabled us to arrive at this truth.

We have hinted at this in our introductory chapter. Let us enlarge upon it.

Will the reader please place before him a large library—say a large state library, containing all sorts of books. Throw them all out in a large pile, and let the pile reach from floor to ceiling, and you have an illustration of that curious chaos which exists only in the minds of imaginative poets, and third-rate pulpit declaimers.

Now arrange them in admirable order—place every book upon its proper shelf, and take care to classify the books not only by the subjects of which they treat, but in reference to the age—the generation or the century, if you please, when each book made its appearance: call the shelves strata, and

the books fossils—and you have a correct view of the distribution of fossils in the earth.

You must not arrange all the histories together in one set of shelves, and all the biographies in another set; but the history and philosophy and biography, etc., of the same age, must go together. So among the fossils, we find radiated animals in every age—molluscos animals in every age—articulates and vertebrates in every age. The same genus of animals may run through all the ages, from the most ancient to the most modern; but it has been ascertained that species exist within certain limits.

To express this in general terms, we may say that the *genus A* is found in all the strata, old and young; but that the species *a*, *b*, *c*, and *d*, of that genus, are discoverable only in the most ancient stratified rocks—that *e*, *f*, *g*, and *h*, of the same genus, are found in the strata next succeeding the oldest—that *i*, *j*, *k*, and *l*, are found in the next above—and so on, till we come to the age of man.

Now, after a careful comparison of the different formations of Europe and America, a most remarkable agreement in organic remains has been found, and we feel authorized to express the belief that *every formation is characterized by its fossils*.

Some years ago I examined with care a great number of fossil sharks' teeth, from the tertiary

beds of South Carolina. Similar fossils have been found all over the world in the same beds—nowhere else. Soon after my examination I came to Mississippi—to the capital of the State. Walking out one evening, I picked up a shark's tooth from a marl bed. Without any hesitation, I determined that I was walking on tertiary land. And such is the fact. The reading of Mr. Lyell's *Visit to the United States*, confirmed my judgment. He shows that the whole region of Central and a part of Southern Mississippi belongs to the Eocene tertiary.

Some two years ago I was trudging along at the foot of some tall hills in the southern part of Middle Tennessee. At night I put up with a clever old farmer, and of course we had to talk till bed-time.

"Sir," said I, "it seems to me you ought to have coal up in those hills."

"Well, why?" replied the old man; "why ought we to have coal?"

"Well, sir, this evening, while walking down the creek slowly, leading my horse, I picked up several of these little things, and I found some of them in the limestone rock."

Here I handed him a *pentramite* characteristic of the mountain limestone, and explained to him that this rock was found under the coarse sandstone which usually supported the coal-beds.

He laughed heartily, said it was a new idea, and continued, "Well, I don't know anything about your fossils; but if you'll go with me in the morning, I'll show you more coal up in them hills than Tennessee can burn in a century."

In the morning we went to the hills and found the coal.

SECTION 10th. *Fossils disclose the existence, perpetuation, decline, and extinction of successive races of animals, revealing vast periods of time preceding the age of man, the various fauna of those periods, together with the varied climatic influences, diversity of vegetation, and atmospheric phenomena.*

The science of comparative anatomy has brought to light what was so long concealed before the close of the past century—the structure and functions of animal bodies.

Cotemporary in its origin with geology as a systematic department of science, they have both kept together, hand in hand, and can never be separated.

The greatest man in France, Napoleon not excepted, is entitled to the paternity of this science. Carried away from the busy hum of Paris, that wonderful microcosm of sin and science, borne by the spirit of science, he found himself seated in the midst of a quiet place full of bones. He was caused to pass by them round about, and lo! they were very

many, and they were very dry. They had been buried for ages, and cycles of ages. The Almighty had concealed them there by his ministers, and the time had come for their exhumation. Presently he heard, as it were, a voice, saying, "Son of man, can these bones live?" He paused and pondered. Again came the voice: "Prophecy upon these bones, and say unto them, 'O ye dead bones, hear the voice of science—I will reconstruct you. Yea, I will, in ideal form, lay sinews upon you, and will bring up flesh upon you, and cover you with skin, and put breath in you, and give you locomotion.'" And behold, there was a noise and a shaking, and the bones came together, bone to his bone.

Let us hear him tell it himself.

"At the voice of comparative anatomy, every bone and fragment of a bone resumed its place. I cannot find words to express the joy I experienced in seeing, as I discovered one character, how all the consequences which I predicted from it were successively confirmed. The feet were formed in accordance with characters announced by the teeth; the teeth in harmony with those indicated by the feet. The bones of the extremity were found set together precisely as I had arranged before my conjectures were verified by the discovery of the parts entire. In short, each species was, as it were, reconstructed from a single one of its component elements."

Allow me to sum up the leading principles of comparative anatomy.

1. The several parts of an animal are admirably adapted to the whole structure.

2. The structure and functions of an animal are easily adapted to the condition of its existence.

3. Mutual relations exist between the several classes.

The great anatomist was so perfectly acquainted with these laws, that he could take a single bone, or even a part of a bone, tell to what animal it belonged, and point out clearly its history and habits.

As, in the construction of any piece of mechanism, the workman always keeps proportion, form, and symmetry in view, so, in the construction of an animal, each part bears a nice relation to the whole. Thus, a tooth having a sharp point and conical shape, and being two or three inches in length, is adapted to a particular form of jaw; the jaw will give the configuration of the head; the head and jaw will give the configuration of the limbs.

Pursuing the investigation still further, the penetrating mind of this close observer has told us what we may all easily discover (like Columbus making the egg stand up)—that the organs of a carnivorous animal are so constructed that every circumstance connected with its mode of living is easy of attain-

ment. Its jaws will be constructed for devouring its prey; its claws for seizing and tearing it; its teeth for cutting and dividing; the entire system of its organs of motion for pursuing and overtaking it; its organs of sense for descrying it at a distance, etc., etc.

The story of the dervish and the two merchants is a "good one" to introduce in this place.

A dervish was journeying alone in a desert. Two merchants met him, and the following colloquy took place:

Der. Have you lost a camel?

Mer. We have.

Der. Was he blind in the right eye?

Mer. He was.

Der. Was he lame in the left fore-leg?

Mer. He was.

Der. One of his front teeth knocked out?

Mer. It was — certainly it was: the very animal.

Der. Was he loaded with honey on one side and wheat on the other?

Mer. Indeed he was. Now, as you have seen him so lately, and marked him so particularly, you can easily conduct us to him.

Der. I have neither seen your camel nor heard of him.

Mer. You daring, impudent rogue! you shall give an account of yourself.

Der. I protest my innocence. I have never seen your camel; but I——

Mer. Stop your lying mouth. We'll take you before the Kadi; and then you may tell your tale.

The poor dervish was arrested, taken before the Kadi, and, after the testimony of the merchants, he was permitted to speak for himself.

Der. I protest, O Kadi, that I never saw the camel.

Kadi. Then how did you know he was blind in the right eye?

Der. I *inferred* it, from *observing* that the grass on the left-hand side of the road was nipped, and that on the right-hand was not touched.

Kadi. How did you know he was lame in the left fore-leg?

Der. I *inferred* it, from *observing* the deep foot-prints on the right, and a feeble impression on the left.

Kadi. How did you know that one of his front teeth was knocked out?

Der. I *inferred* it, from *observing* that a single row of grass stood all along the track of his grazing, while it was eaten down on both sides.

Kadi. How did you know he was loaded with honey on one side and wheat on the other?

Der. I *inferred* it, from *observing* the leakage—the bees on the side of the honey and the ants on the side of the wheat.

Kadi. You can go.

Now it is by this kind of *observation* and *inference* that the geologist reads the history of the past. He reads the *existence* and *habits* of a genus or a species of animal in its fossil skeleton or in its marks. He reads the *perpetuation* of that species in the continuous presence of the skeleton through a series of strata. He reads the *decline* in the *paucity* of specimens as the world grows older. And he reads the *extinction* in the negative fact that no remains at all of such skeleton can be found, after a most diligent search, in any strata above a certain designated line.

In a word, a careful and competent observer can tell when a particular animal commenced its career—how long, comparatively, it existed, and when it expired. Of course we do not mean that the precise number of years can be calculated, but the ages. We count, in geological arithmetic, by centuries and decades of centuries.

Let us look at the record a few moments.

The genus *Teretratula*, a brachiopod mollusc,

began its career very early in the history of organic beings. We say so, because we find it low down in the most ancient fossiliferous rocks; we therefore believe it commenced its career at the time indicated. We have traced this genus with our eyes and fingers, from this low position up through the Silurian, Devonian, and Carboniferous systems. Then leaping the strata which are not to be found in the United States, we have again "run it up" through the cretaceous, tertiary, and modern formations, until, at last, we have obtained living specimens from the present ocean.

The genus is not extinct; but several species have "died out." In general, all of the different systems just mentioned contain different species.

Again, we have marked the commencement, progress, and extinction of the Trilobite. We have seen here in the Western Hemisphere what has been observed on the continent of Europe—that it began its being in the age now designated Silurian, among the first formed of animal life,—that it continued on through the entire period of the Old Red Sandstone, and expired in the Carboniferous. Not a trace of the animal can be found in any of the rocks above the coal.

It is plain to see, that we have an exhibition of one striking fact,—that is, *a succession of species en-*

during through a succession of ages. Now, let the reader ask himself a very plain question. How long a time is necessary for the extinction of a species? The answer, perhaps, may be, Different times for different animals. Very well. This is doubtless correct. But can we approach something like a correct answer in the study of animals of the human epoch? We have one notable example. The *Dodo* became extinct in the 17th century. Then it lasted upon the earth more than 5000 years.

Nearly all the species of animals created with man still live, and how long they will exist we cannot tell.

Is it unreasonable then to suppose that any given species of Trilobite must have continued its existence in the waters of the old ocean for five thousand years? And that this was succeeded by another, and this by a third, and so on, until the whole family became extinct?

If so, we have unquestionable proof of the lapse of many thousand years during the deposition of the oldest fossiliferous rocks.

But let us look a little further. We find by turning up the record (the rocky strata,) that certain forms of fishes did not begin their course until a late period of the existence of the Trilobite, — that these, in the course of ages, became extinct and

gave way to other species. By the same course of reasoning, we have many thousand years added to the former.

Once more. We discover the introduction of large reptiles long after the extinction of the earliest fishes,—and the introduction of mammals long after the extinction of these reptiles,—and the introduction of man after the extinction of these mammals. We leave the reader to draw his own inference, simply remarking that we are not able to calculate the time, by several thousand years.

It is thus we make out the *Fauna* of the different ages. In the same way we determine the *Flora*. There is no guessing in the matter. Fossil botany is a real tangible matter. We see and handle the forms which were once magnificent trees standing erect in their native forests, and we know that we cannot be deceived.

SECTION 11. *The practical value of fossils in the exploration of strata is very great.*

I will undertake to illustrate this by an anecdote. Some fifteen years ago I was engaged in a geological ramble in Tennessee.

One night I put up with a clever old farmer, who seemed disposed to do all in his power for my accommodation. At the supper-table he informed me that he had discovered a coal mine on his place.

I informed him in a very respectful style, that he must be mistaken; there was no coal nearer than a hundred miles, (the coal beds of the Cumberland Mountains.)

"And, pray, sir," said the old gentleman, "how do you know; have you ever seen my coal mine?"

"No, sir," said I, "and I never expect to see it on this farm." He replied, with great emphasis,

"I'll show it to you in the morning, sir, about a half mile up the road," and then the conversation ceased.

In the morning we started to the *coal mine*(?) On my way I gathered up a number of fragments of limestone, and bye-and-bye, found what I knew to be a characteristic fossil of the Lower Silurian strata—the *Spirifer Lynx*. I showed it to him, described the relative position of the coal-bearing rocks and those beneath them, and tried to explain to him that the fossil which I held in my hand was always found in the rocks below the coal. "You are too low for coal here," said I. "Oh, come along," rejoined my old friend; "come along, and let me show you that you geologists don't know every thing." On we went, and presently we arrived at the treasured spot. *It was a layer of bituminous shale*. It was of no account; and I advised him to give up the enterprise, but he persisted,

declaring that he did not believe in geology. The result was, he spent two or three hundred dollars, made considerable *noise* and *smoke*, and had a large pile of slaty *ashes*.

Some ten years ago I was invited to deliver a lecture before the Legislature of Mississippi, on the subject of Geology and a Geological Survey. I took occasion to say to that body, that coal would not be found in the State, unless, perhaps, at an impracticable depth. I made this prognosis from ascertaining that the fossils of all parts of the State, collected by the Geological Society, clearly designated the *Eocene tertiary*, reposing on the *Cretaceous* formation, and that the latter dipped deep under the Mississippi river at Vicksburg.

The surveys of the State made subsequently, confirm the truth of my prediction.

SECTION 12. *The vast range of organic remains, both vegetable and animal, from the lowest sedimentary rock up to the modern surface, where the last of animal existence stands upright in physical perfection, develops a mighty plan, which must convince every reasonable being, aided by revelation, that our highly favored globe is the work of a wise and omnipotent God.*

The succession of geological ages is the unfolding of a plan conceived in wisdom, regulated by goodness, and executed by power. These attributes are

displayed in perfection in all the organic remains of the globe. They are the attributes of a pure and an all-comprehending intelligence, — an intelligence capable of contemplating alike the past, present, and future. They are the attributes of *God*. And when we speak of God, we mean not an abstract principle — the ideal conception of a mystic philosopher — the attenuation of electricity, or the mere embodiment of purity and power; but we mean the everlasting *God* that communed with Moses and the prophets, and sent his Son to repair the ruins of the fall.

We do not believe that man can acquire a correct idea of the being of God, or of his moral plans and purposes, from the study of the structure and functions of the earth. The “religion of Geology” will never take a man to heaven, notwithstanding it may teach him many useful lessons concerning the providence of the High and Holy One who inhabits eternity.

The earth is a volume wherein we may read the transactions of natural providence; the Bible is the book of moral providence. Without the latter, we could not interpret the former in any of its moral bearings. We should be as blind as Epicurus, or any atheistic philosopher who talks of a fortuitous concourse of atoms.

There has been much wild conjecture about the God of Nature, and we regret that any one versed in geology should give countenance to any hypothesis that favors the degraded conceptions of the atheist.

We have heard lecturers discourse beautifully on the manifestations of power, wisdom, and goodness, as though they might have memorized the Bridgewater treatises; and yet, when we came to inquire of them privately about their views of the "great first cause," we found them denying the necessity of any other than a natural revelation, and stoutly insisting that God was a convenient name for the grand vital principle of the universe. Against such a "vain and foolish philosophy" we enter our protest; and in place of attenuated matter, or a mental abstraction, we humbly present the claims of the true and living God — the God of creation, providence, and redemption.

Fossil remains and stratified deposits exhibit a plan.

The study of the plan exhibits the designs of a Being whose "thoughts are above our thoughts."

Every plan, whether human or Divine, that works well, must involve a variety of means converging to a common end.

That which is first in design is last in execution.

These two principles regulate all the operations of intelligent agents, and they are the essential laws of creative and providential power.

“Every house is built by some man, but he that built all things is God.”

The prudent builder has an ideal house completed in his mind before he commences his work. The ideal house is first, the actual house is last. The former is the mental design, the latter the manual execution.

This is clearly manifested in the great work of the Divine Builder — the Supreme Architect.

He proposed the creation of a world for the abode of man. This was the first grand design.

“The perfect world by Adam trod” presents to our view the last act in the drama of creation. All intermediate designs were subordinate to the great end.

Suppose, for the sake of argument, we admit that the teaching of the Holy Scriptures concerning God is purely theoretical. Has any man ever offered a better *theory* concerning the first cause, than the one set forth in the Bible? Is it not the best theory ever projected? Why not adopt it? Man will have some hypothesis. Take the best, and discard all others.

But we rejoice to believe that God has spoken to

man. In all the majesty of his nature, he has declared himself the Lord — the Lord God — Creator, Preserver, and Benefactor.

“Out of heaven he made thee to hear his voice, that he might instruct thee; and upon earth he showed thee his great fire, and thou heardest his words out of the midst of the fire.”

“Behold, the heaven and the heaven of heavens is the Lord’s — the earth also, with all that therein is.”

“The sea is his, and he made it; his hands formed the dry land.”

“The Lord our God is *one* Lord.

“From everlasting thou art God.”

From these passages we learn the *eternity* of God — his *unity* and his *creative power*; and with the volume of inspiration in our hands, we may go forth and see the impressions of his power in every hill and valley, and in all the deep places of the earth. In imitation of David, we may say, mountains and all hills, fossil palms and mighty mastodons, trilobites, and all corals, let them praise the name of the Lord.

CHAPTER VIII.

The Living Ages of the Globe Classified.

WE arrange the living ages of the globe into four great chapters: viz., I. *The Palæozoic Age*; II. *The Mesozoic Age*; III. *The Kainozoic Age*; and, IV. *The Androzoic Age*.

We subdivide each of these ages into periods; and, in order that the reader may obtain a correct view of the entire arrangement, we here present the whole in tabular form.

IV. ANDROZOIC AGE.	{ <i>One Period</i>, extending from the creation of man and his coteremporaries to the present time; marked by alluvial deposits, bones of recent animals, shells of living molluscs, human remains, and works of art. Modern deltas and coral reefs.
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III. KAINOZOIC AGE.

8. *Period* of the boulders and drift of Northern Europe and North America—cavern deposits and osseous breccia; marl bluffs of the Mississippi, and loess of the Rhine.

All the shells in many localities belong to living species. No human remains. Not more than a third of the shells in any locality extinct. A majority of the mammals extinct. Remains of large ruminating animals—mastodons and elephants. (*Pleistocene and Pliocene Tertiary.*)

2. *Period* of extinct mammalia. Two-thirds of the shells extinct. (*Miocene Tertiary.*)

1. *Period* of the pachyderms of the Paris basin. Fossil shells nearly all belong to extinct species.

Plants indicate a tropical and subtropical climate. (*Eocene Tertiary.*)

II. MESOZOIC AGE.

3. *Period* of the large saurians. Chalk and greensand deposits. Cephalopods, such as ammonite, hamite, scaphite, and belemnite. A deep sea covering a large proportion of the then existing land. (*Cretaceous.*)

2. *Period* of enormous land reptiles: viz., pterodactyle, iguanodon, megalosaurus, plesiosaurus, trionyx, and emys.

Fresh-water shells. Alternations of fresh-water and marine deposits.

Plants—cycads and conifers.

Mammalian animals first introduced. (Preponderance of ganoids. *Wealden and Oolite.*)

1. *Period* of the batrachian reptiles.

Plants belonging to ferns, cycads, and conifers. (*Lias and Trias.*)

I. PALÆOZOIC AGE.

4. *Period of the new red sandstone.*

Thecodont saurians and heterocercal fish. This formation is now styled (*Permian*).

3. *Period of the coal formation.*

Great thickness of strata of fluvio—marine origin, with beds of coal of vegetable origin, based on soils retaining the roots of trees. Four or five of the oldest of known reptiles.

Brachiopods—cephalopods and crustaceans.

Crinoids and corals. (*Carboniferous*.)

2. *Period of fishes. One reptile only. (Devonian.)*1. *Period of invertebrates.*

Trilobites, brachiopods, cephalopods, orthoceras, etc., abundant.

No land-plants. (*Silurian*.)

CHAPTER IX.

First Period of the Palæozoic Age. — The Silurian formation — Invertebrate Animals, and Marine Plants—No Vegetation on the Land—The deep, deep Sea.

THE Silurian system or formation is generally regarded as the oldest of the palæozoic rocks. The Cambrian, as may be seen by reference to our table, has a nominal position below it; but, upon the authority of Mr. Lyell, we are authorized to state that no organic remains have been discovered in the Cambrian, so as to entitle the series of strata to the appellation of fossiliferous.

In speaking of the Silurian system, we may notice its position, its range, its extent, the members of the group, and its fossils; after which we shall be prepared to make some physical deductions, and draw a few moral inferences.

a. The position of the Silurian strata. — This series of rocks overlies the granite, and underlies all the other fossiliferous rocks. In many places it appears at the surface, in many others it is deep down in

the earth, so that it is unavailable except by hard digging and boring.

I am aware of the difficulty which exists in the mind of a student in identifying the different formations, as presented in the books; and right here the question presents itself, "Where shall I find the Silurian rocks?" "I have read the books," says one, "and I have seen the whole thing laid out very handsomely on a map, but I feel at a loss to find the strata on the earth or under its surface."

We understand the nature of the difficulty; and nothing but actual observation, aided by the instruction of a practical geologist, can ever remove it from the mind of him who really desires to see with his eyes and handle with his hands the "*subject matter*" of his curiosity.

We will try, however, to assist those of our readers who have not studied the language of rocks, by selecting some prominent localities in the United States, and pointing out some of their prominent features.

Have you ever been at Nashville, Tennessee? Did you ever notice the huge blocks of limestone they have been quarrying out there for many years past? If you have seen those rocks, you have seen an exhibition of the Silurian system. Throughout the whole of Middle Tennessee the same system

prevails. Perhaps you have visited Frankfort and Lexington, Kentucky, — Harrodsburg Springs, and other localities in that region. If so, you travelled over Silurian strata, — you trod upon the remains of animals that lived and died in the Silurian ocean, where no voice was heard by human ear, and no sound was uttered but the lashing of the wild waves.

You may have spent a few days in Cincinnati. Probably you observed the big rocks and the scattered fragments in the hills around, and the same on the opposite side of the Ohio river. All that region belongs to the Silurian system. Those hard limestone rocks were once in the condition of muddy, sedimentary matter, floating about in an ocean, ante-dating Noah's flood, more than a million of years. After a quiet deposit and the entombment of myriads of animals, and a long rest, they were upheaved from the bottom of that ocean, and brought to the air, leaving the surface of the old residence far below. And there they are, thoughtful reader, *for your use and mine*. It is a comprehensive thought, and it suggests to our minds a comprehensive power far above chance, or plastic principle, or electric agency, or any imponderable known to man.

Have you been to Niagara? If you have, just go with me again for a few moments, in imagina-

tion, and let us take a stroll. Leaving the International, we will pass down quickly to the Ferry House, and, turning to the right, we will descend the stairway, step by step, until we reach the bottom. Now, we jump into a skiff, and we are out in the river. Oh! you look at the water. Well, you love the sublime: look on, I cannot prevent you. But now, if you can take away your eye for a few moments from the tremendous fall, — let me ask you to look up at the everlasting walls of rock — those high mural banks below the falls. You behold a sublime exhibition of a part of the Silurian deposit. You look up 200 feet to the drift surface, and if your eyes could penetrate green waves, you might look down through the angry water and see on the sides of the stream the same compact masonry, perhaps for 200 feet more. Where now you are floating on the water, it was, in the primitive ages of the globe, a solid block of limestone. The river has cut it out. But we must notice,

b. The vertical and horizontal range of the Silurian strata.—The vertical range is about 10,000 feet, not far from 2 miles; but there is no one place where we find all the members of the group in a direct vertical position. The horizontal range embraces three continents. Beginning in our Western States,

(Indiana, for example, and Middle Tennessee), we may trace them in an easterly direction, occupying a belt of about 10 degrees of North latitude, (from the southern line of Tennessee to the northern boundary of New York, until they dip and disappear under the Tertiary and Alluvial deposits of the Atlantic coast, and become lost in the ocean. Re-appearing in Great Britain, they form there an important group; again in Lower Germany, and Russia, in Tartary, and Thibet, and Siberia.

c. Members of the group.—The following exhibition of the relative order of the strata and their thickness, is the result of my observations made in Kentucky, Tennessee, Ohio, and New York, in connection with a careful examination of Murchison's "Siluria," and Lyell's Manual.

Upper Silurian.	{	Removing the soil, we have	
		Sandstones and Shales.....	1,000 feet.
		Argillaceous Limestone.....	800 "
		Shale	800 "
		Concretionary Limestone	1,000 "
		Argillaceous Shale.....	1,000 "
Lower Silurian.	{	Blue Shaly Limestone.	
		Shale—Bituminous and Aluminous.	
		Compact Limestone.	
		Heavy Sandstone.....	4000 feet.

Professor Ansted, in his "*Ancient World*," says, "In the British Islands, and very generally in other

countries, this lower group of rocks consists of a greyish-colored sandy stone, often slaty or flaggy, and containing much clayey matter, sometimes including poor bands of limestone, and remains of shells, etc.

“The materials from which it was formed were obtained from older, and probably from igneous rock pounded still more finely at the bottom of the water. They likewise exhibit indications of very extensive disturbance, and in some cases, seem to have been deposited alternately with great masses of igneous rock poured out like lava from a volcano, but emptied through the bed of the ocean, and soon covered up with new deposits.”

d. Fossils of the Silurian. Animal Remains. Vertebrates. — In the lowest sandstone of the Lower Silurian group, it was supposed the footprints of a fresh-water tortoise had been discovered. “The footprints are in pairs, and the pairs extend in two parallel series, with a channel exactly midway between the right and left series. The interval between the right and left pairs, measured from the inner border of the small prints, is three inches and a half; and from the outer border of the exterior, or large prints, is seven inches. The shallow median track is one inch and a quarter in breadth,

varying in depth, but not in its relative position to the right and left footprints."

This is the only vertebrate animal of the Chelonian kind reported in the Silurian strata, and this report was made in 1847; but since then Professor Owen has pronounced them to be the tracks of crustaceans.

In addition to this, we can only record the fact that a few remains of fish have been detected in the lower part of the Upper Silurian. These fragments have been found in Great Britain, Russia, and the United States. They belong to the placoid fish, consist chiefly of spinous processes, and are called *Icthyodorulites*.

Articulates. — The articulated animals belong almost wholly to the annelids and crustaceans. Of the annelids the following are the principal:

Cornulites Serpularius, *Tentaculites Ornatus*, *Tentaculites Annulatus*, and *Serpulites Longissimus*.

These have been described by Mr. Murchison.

Of the crustaceans, the *trilobites* appear to have had sole occupancy of the waters; and their fossil remains, now found scattered in all continents, indicate a wide range and great abundance.

We will give some special attention to this animal. A trilobite is an animal more nearly allied to the crab kind than any living crustacean.

“The anterior segment of the trilobite is composed of a large semicircular or crescent-shaped shield, succeeded by an abdomen, or body, composed of numerous segments, folded over each other, like those in a lobster’s tail, and generally divided, by two longitudinal furrows, into three ranges of lobes, from which they have derived the name of trilobites. Behind this body, in many species, is placed a triangular or semilunar tail, or post-abdomen, less distinctly lobed than the body.”—*Buckland*.

But the most wonderful organs of this crustacean are the eyes. The eyes of living insects, crabs, lobsters, etc., consist of a number of very small facets, or lenses, placed at the extremity of conical tubes. The number of facets of a common butterfly exceed 30,000.

“If we examine the eyes of trilobites with a view to their principles of construction, we find, both in their form and in the disposition of their facets, obvious examples of optical adaptation.

“In the *Asaphus caudatus*, each eye contains at least 400 nearly spherical lenses, fixed in separate compartments on the surface of the cornea. The form of the general cornea is peculiarly adapted to the uses of an animal destined to live at the bottom of the water. To look downwards was as much impossible as it was unnecessary to a creature living

at the bottom; but for horizontal vision, in every direction, the contrivance is complete. The form of each eye is nearly that of the frustrum of a cone, incomplete on that side only which is directly opposite to the corresponding side of the other eye, and in which, if facets were present, their chief range would be toward each other across the head, where no vision was required. The exterior of each eye, like a circular bastion, ranges nearly round three-fourths of a circle; each commanding so much of the horizon that where the distinct vision of one eye ceases that of the other begins; so that in the horizontal direction the combined range of both eyes was panoramic." — *Ibid.*

We thus find, in trilobites of the Silurian rocks, the structure and functions of the eye corresponding to the offices of the organ of vision in living representatives.

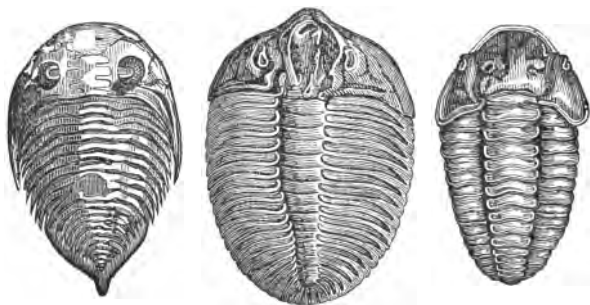
About forty years ago, geologists numbered five genera and seventeen species of trilobites. The number has gradually increased, until now they enumerate about forty-five genera and 250 species. A complete treatise on trilobites would fill a quarto volume of several hundred pages.

The following are the names of a few we have collected in the great Silurian belt of the United States:

Asaphus Caudatus, *Calymene Bufo*, *Calymene Blumenbachii*, *Trinucleus Ornatus*, and fragments of *Isotelus*.

In 1838, Dr. Locke, of Cincinnati, Ohio, discovered the fragments of a trilobite which indicated a very large size. They were portions of tails; and, according to mathematical measurement, the restoration presents to the eye an animal some eighteen or twenty inches long. He named it *Isotelus Megistos*.

Doubtless it was just such a crustacean that made the large tracks upon old Silurian mud, which Professor Owen mistook for the footprints of reptiles.



Trilobites.

We proceed to notice

The Molluscs of the Silurian.—Three classes of molluscous animals have been well defined in the Silurian strata, both in Europe and America: viz., *Brachiopods*, *Gasteropods*, and *Cephalopods*.

Of the *Brachiopods*, we have in our collection,

Terebratula aspera, *T. reticularis*, *T. Wilsoni*, etc.

Spirifer Lynx, *S. trapezoidalis*, *S. cuspidatis*, etc.

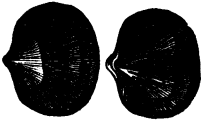
Orthis testudinaria, *O. orbicularis*, etc.

Leptena depressa. *Productus antiquatus*.

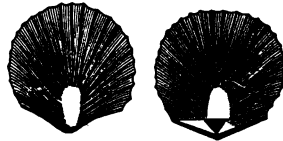
Pentamerus oblongus. *P. Knightii*.

Of the *Gasteropods*, we may notice the *Loxonema*, *Pileopsis*, and *Buccinum*.

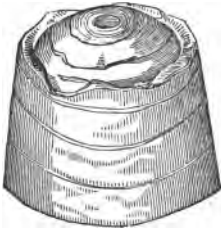
Of the *Cephalopods*, we enumerate *Orthoceras* (several species), *Cyrtoceras*, and *Lituities*.



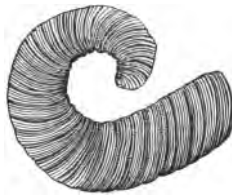
Orthis Orbicularis.



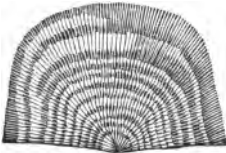
Orthis Testudinaria.



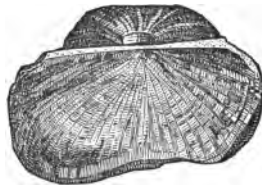
Orthoceras Conica.



Lituities Giganteus.



Productus Depressus.



Productus Antiquatus.



Spirifer Trigonalis.



Terebratula Digona.



Terebratula Octoplicata.



Pentamerus Knightii.

We notice lastly the *Radiata of the Silurian*, and designate a few localities.

These belong to the *Corals*, the *Crinoids*, and the *Star-fish*.

<i>Corals</i> .—Favosites Fibrosa	Ky., Tenn., Ohio, and N. Y.
“ Gothlandica.....	Falls of Ohio and Louisville.
“ Spongites.....	“ “ and Tennessee.
“ Basaltica	“ “
Sarcinula Costata	“ “
Aulopora Serpens	“ “ and Tennessee.
“ tubæformis	“ “
Catenipora escharoides	“ “ and Tennessee
Stromatipora polymorpha...	“ “
Lithostrotion.	
Cyathophyllum turbinatum..	“ “
“ (various other species.)	



Cyathophyllum Turbinatum.



Catenipora Escharoides.

<i>Crinoids.</i> —Caryocrinus Ornatus	Tennessee
Caryocrinus (?)	“
Pentramites Reinwardtii	“
Eugeniocrinites Mespiliformis	“



Caryocrinus Ornatus

Star Fish.—Mr. Murchison has figured some beautiful forms of star fish from specimens taken from the Upper Silurian of England. They belong to the genus *Uraster*. We have seen nothing of the kind in the United States.

Physical Deductions. — The superficial geography of the Silurian times was quite a different picture from the present aspect of the earth.

Taking a bird's-eye view of our portion of the Western Hemisphere, we may notice several interesting points. The ocean had undisputed sway throughout a great portion of the south and southwestern part of the United States. Look at Texas, Louisiana, Mississippi, South Alabama, Florida, South Georgia, and the eastern portion of the Carolinas. Where their cotton fields now bloom in beauty, and bear fruit to clothe the nations, not a particle of dry land then existed. Instead of land, and houses, and fields, and horses, and the proud oaks lifting their arms to heaven, there was a fathomless ocean.

Could a mighty angel, endowed with the capacity of limitless vision, have been permitted to take his position on the present site of Nashville, Tennessee, he would have seen what mortal eyes have never beheld — the water of the ocean covering nearly all the western district of the State. Where Memphis now sits as a young queen, the old ocean lifted up his waters, and the Mississippi river was a thing in the future.

Southern and Middle Arkansas was under water.

The northern part of the State, in connection with the southern and middle part of Missouri, and a long strip of Indian Territory, constituted an island. Illinois was under water; Indiana was out. The eastern and western parts of Kentucky were submerged; all the centre was out. The vast territory west of the Missouri river and of the ninety-fifth west meridian, as far as the base of the Rocky Mountains, and extending from about the 48th degree of North latitude, down to the present Gulf of Mexico, was one great Mediterranean Sea.

In a word, the whole region was cut up into islands and peninsulas.

Turning our attention for a few moments to the condition of things in the Eastern Hemisphere, we learn that "the largest domain then above the surface of the water, in the regions of the future continent of Europe, was Scandania and a part of Russia. England and Scotland are only marked by a few islands along the existing western coast; Ireland, by a few others, placed at the corners of the present island. All France is represented merely by an island, corresponding to the central tableland of Auvergne, and by some strips of land in Vendée and Brittany, and in Calvados. In Germany, Bohemia, forming a great island, the Hooz,

and the plateau of the lower Rhine; small portions of the Vosges and of the Black Forest, and some lowlands on the spot occupied by the Alps, between Toulon, Milan, and Tyrol, compose an archipelago which is to become the centre of the continent. All the regions of the South, except parts of Spain and Turkey, do not yet exist."—*Guyot*.

Does the reader suppose this a fancy sketch? We have only to answer him, It is impossible to dispute the evidence of our senses. It is a sketch from nature. God himself drew the original picture.

Such was the inorganic world at that early period. Shall we inquire what was the state of organized bodies? The answer is easily given. The rocks afford us abundant information. Not a tree—not a single tree—stood upon the land. No flowers adorned the earth. The time had not yet come for trees and flowers. They were not needed. A few, very few sea-weeds constituted the vegetation of the globe.

We have seen that three of the four great divisions of the animal kingdom were represented—the radiate, molluscous, and articulate.

They were carnivorous animals. We suppose so for two good reasons:—1st. There was no vegetable matter to subsist on; and, 2d. The same kind of

animals at this time are carnivorous. This, then, is our conclusion — they lived on one another. They ate their food in quietness. Not a sound went up to indicate the rage of a destroyer or the murmur of a victim, but with singleness of instinctive purpose they served their day and generation, fell asleep, and had an ocean burial. The Creator is the Author of life and death.

CHAPTER X.

Period Second.—The Devonian or Old Red Sandstone.—Fishes fairly introduced, and diffused. — One Reptile recently discovered. — All the Grand Divisions of the Animal Kingdom represented.

THE Devonian system, or Old Red Sandstone, lies immediately above the Silurian. The reader must bear in mind the explanation we have given of the relative order of the different strata—the absence of some in certain situations—the dip here, and the rise yonder, etc.,—so as to be familiar with the remarkable fact, that while certain rocky strata may be, topographically, 1,000 feet above certain other strata fifty or a hundred miles distant, the former may be geologically under the latter.

The Silurian rocks of New York, Ohio, Kentucky, Indiana, and Middle Tennessee, at their summit, are high in the air. The alluvial plains of Louisiana and Florida are “low down.” Draw a line from the Silurian outcrop on Mt. Adams, Cincinnati, Ohio, and let it extend in a horizontal direction over New Orleans. Look at it, in your

imagination, and you will find Mt. Adams to be some 1,500 feet above the alluvial deposit of New Orleans; and yet, it is very plain, even to a beginner in geology, that the alluvium of New Orleans is far, far above the heavy limestone rocks of Mt. Adams.

One word explains the whole matter. That word is *Dip*. The old formation dips under the new one.

With this explanation, observe, that the Devonian rocks lie above the Silurian, although we may sometimes notice that they are absent—or, to speak with greater propriety, the waters of the old ocean did not deposit the Devonian strata in some localities—and, likewise, they may be found reposing in some places on the Azoic rocks. *The Devonian rocks are never found under the Silurian.*

The entire vertical range is about ten thousand feet.

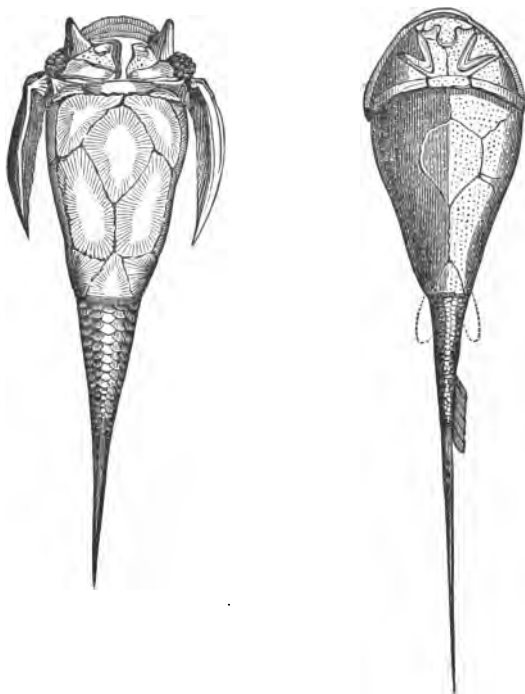
They have been explored with great care in Russia, Germany, Great Britain, and the United States, and, from all our information, we are enabled to present the following order:

Strata 10,000 Feet Thick.

Upper.	{	Yellow Sandstone.
		Impure Limestone.
		Gritty Red Sandstone.
Lower.	{	Red and Variegated Sandstones.
		Bituminous Schists.
		Coarse Sandstone.
		Great Conglomerate.

Fossils of the Devonian. — A number of the fossils of the Devonian are quite similar to those of the Silurian, and a few are identical. No land-plants yet, no fluviatile shells. Life seems to be limited to the ocean.

The highest forms of *vertebrated* animals were the fishes and reptiles.



Fossil Fishes of the Devonian System.

There was a remarkable fish of that early period, styled the *Pterichthys Cornutus*. It was a flying-fish, so we may judge; for it had wings. Another was the *Coccosteus Oblongus*. And a third has been named *Cephalaspis Lyelli*.

Others have been described by Hugh Miller, Agassiz, and Murchison, under the following names: *Dipterus*, *Diplopterus*, *Osteolepis*, *Glyptolepis*, *Cheirolepis*, *Diplacanthus*, and *Cheiracanthus*.

All these fishes belong to the *placoid* and *ganoid* orders, and they all had heterocercal tails, or tails unequally bilobate.

The only reptile discovered in the Devonian is the *Telerpeton Elginense*, found in Elgin, Scotland, in 1842. It is four and a half inches long.

It was, probably, an air-breathing animal, and lived on land. It must have had a lonesome time; for there was scarcely any other creature living on the land at that period, and one or two small tree-ferns (one or two species, we mean) may have been growing.

The *Cyclopteris Hibernicus* (a tree-fern) has been referred to this period by Professor Forbes.

The *Articulates* of the Devonian are represented by crustaceans quite similar to those of the Silurian.

The *Calymene Bufo* and *Phacops Granulatus* occur in the Devonian limestone of the United States and Europe.

The *Molluscs* were plentiful. In addition to those already mentioned in our previous chapter, common to the two formations, we may mention the *Terebratula Concentrica*, the *Spirifer Cultrijugatus* and *Mucronatus*, several species of *Orthis*, *Chonetes Nana*, *Luxorema*, etc., etc.



Spirifer Mucronatus.



Terebratula Concentrica.



Lexonema Nexilis.

The *Radiates* flourished largely.

The coral reef at Louisville, Kentucky, was formed by polyparia of the Devonian as well as the Silurian period.

All that we have mentioned continued during the two periods, and there were several that belonged exclusively to the Devonian.

CHAPTER XI.

Third Period of the Palæozoic Age—The Carboniferous Formation—
Great Coal-Basins.

IN describing the Carboniferous formation, the following order may be observed:

1. Relative position.
2. Members of the group.
3. Fossils of the coal region.
4. Climate of the coal period.
5. Coal-beds of the United States.
6. Probable antiquity.
7. Domestic and commercial value.
8. Moral reflections.

1. *Relative Position*.—In the ascending series, the Carboniferous rocks lie above the Devonian or Old Red Sandstone. They are found immediately beneath the Permian, in their regular order, though it often happens that the latter system is absent. This is the case in the United States. In all the coal-beds which I have examined, the coal has been very near the surface; and no Permian rocks, or any

other, except some members of the coal group, were lying above.

It is a matter of practical importance to know that coal is not found in or below the Devonian and Silurian rocks, nor above the Secondary and Tertiary rocks. A knowledge of this fact enables a miner to economize his labor, and not dig blindly for coal where it cannot be found.

2. *Members of the Group.* — Geologists have included in the Carboniferous system a number of shales, sandstones, grits, and limestones, besides the coal proper; and the entire group embraces a vertical range of nearly 6000 feet.

In England they are arranged as follows:

Descending from the surface, they place

- | | | |
|---|---|--|
| 1. Coal Measures..... | { | Strata of shale, sandstone, and grit, with occasional seams of coal, from 600 to 12,000 feet thick. |
| 2. Millstone Grit..... | { | Coarse conglomerate, with beds of shale, usually devoid of coal, occasionally above 600 feet thick. |
| 3. Mountain or Carboniferous Limestone. | { | A calcareous rock, containing marine shells and corals, devoid of coal. Thickness variable — sometimes 900 feet. Varieties of black, grey, and variegated marbles. |

In a vertical section of the Cumberland Mountains, in East Tennessee, which I examined a short time since, I found the following order:

Soil and Gravel	2 feet.
Brown Sandstone	5 "
Shale	2 "
Coal.....	8 "
Clay.....	2 "
Shale	10 "
Coal	2 "
Sandstone	10 "
Conglomerate	5 "
Coal	3 "
Clay	3 "
Shale	5 "
Heavy Slate Rock, called Bastard Limestone...	30 "

On the western declivity of these mountains the coal occupies a horizontal position. On the eastern, the whole series of strata have been tilted up in many places by some disturbing force from below.

3. *Fossils of the Coal-bearing Rocks. The Flora.*—There must have been a great contrast in the aspect of the earth between the Silurian and coal epochs.

Then, as we have seen, there was no vegetation on dry land. During the coal period there were large forests. The number of plants discovered in the Carboniferous series exceeds five hundred species. They belong principally to the ferns, which are cryptogamous plants.

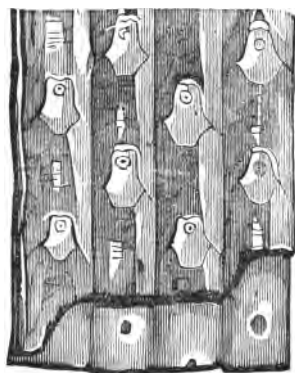
In most of our coal-beds we find impressions of the fronds or leaves of the tree-fern. They may be seen in the coal itself, or in the shales, and sandstones, and clay ironstones of the coal-measures.

Tree-ferns are not very common at this time. They are found in Australia, Brazil, and some tropical islands. Travellers describe them as rising to a height of forty and fifty feet, and looking very much like the palm. They have their organs of fructification on the leaves. They are named by placing a suitable prefix to the word *pteris*, a fern. Thus we have *Sphenopteris* (wedge-leaved fern), *Pecopteris* (sheep-skin fern), *Caulopteris* (quill-like fern), and *Neuropteris* (nerve-like fern); all of which occur in the coal. They were all acrogens.

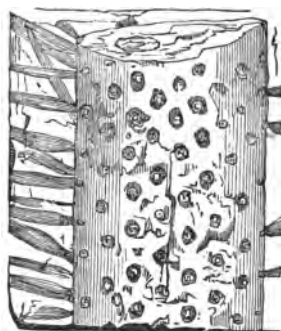
Next to the Ferns we may notice the *Lepidodendron* (*lepidos* a scale, and *dendron* a tree,) having sharp-pointed leaves, and scaly cones—the *Sigillaria*, marked with fine flutings and scars in regular



Lepidodendron Elegans.



Sigillaria pachyderma.

*Stigmaria ficoides.*

order, sixty feet long and five feet in diameter—the *Stigmariæ*, the roots of the *Sigillaria*—the *Equisetaceæ*, (resembling the living “horse-tail” growing in marshes), which attained to the size of trees—and the *Asterophyllites*, which included a number and variety of beautiful plants.

From all the examinations heretofore made, it appears that an overwhelming majority of the plants were *acrogens*. A grove of carboniferous trees reproduced by an artist, would bear a close resemblance to a New Zealand forest.

Erect Fossil Trees.—In several parts of the world fossil trees and fragments of trees have been found in an erect position in the coal formation. The finest exhibition of a fossil forest is in Nova Scotia. Indeed, there is a succession of forests occurring at different levels. Mr. Logan, an intelligent geolo-

gist, and the government surveyor, found erect trees at seventeen levels, extending through a vertical thickness of 4,515 feet of strata, the trees being mostly large *Sigillariæ*. The average height of the trees was 10 feet: diameters varying from 1 foot to 4. Most of them terminate downwards in seams of coal. "They are known to extend," says Mr. Lyell, "over a space between two and three miles from north to south, and more than twice that distance from east to west, being seen in the banks of streams intersecting the coal field."

The Fauna of the Coal Period. 1. *Vertebrates.* *Fishes and Reptiles.* — Agassiz, the unrivalled ichthyologist, describes more than one hundred and fifty species of *ichthyolites* belonging to the coal strata, some evidently being the bones of sharks and rays, and not a few partaking of a lizard-like character, and hence called *Sauroid*.

Among the latter were the *Megalichthys*, and the *Holoptychius*, fishes of great size, and more highly organized than any living fish.

Sixteen years ago the first reptile was discovered in the coal measures. Three years later, three species of air-breathing reptiles were found in Germany, and, at the time of the first discovery, Dr. King, of Westmoreland county, Pennsylvania, described twenty-three foot-prints of an air-breathing

reptile, plainly impressed upon the sandstones of the coal measures of that county. The animal has been named *Cheirotherium*.

Articulates.—The Trilobite is the only crustacean described by geologists in the coal formation.

It is here we discover the extinction of this species. Flourishing from the beginning of the *Silurian*, and gradually diminishing in the *Devonian*, it expires in the *Carboniferous*.

The three genera *Phillipsia*, *Griffithides*, and *Brachymetopus*, found in the mountain limestone of the coal series, are the last of the race.

Molluscs. — Among the molluscs we find the *Brachiopods* predominant, most of the forms gathered in our country being referable to three genera—the *Spirifer*, *Productus*, and *Orthis*.

In various parts of the great Appalachian coal field we have collected the following:

Spirifer striatus—*S. cuspidatus*. *S. undulatus*.

Productus punctatus. *P. semireticulatus*.

Orthis Michelini. *Orthis testudinaria*.

Terebratula, (several species.)

Of the univalve shells the *Euomphalus pentagultus* is the most common in the mountain limestone.

We find also the *Turritella*, *Buccinum*, and of the *Cephalopods* we have collected the *Orthoceras*, the *Goniatites*, and *Bellerophon*.

Radiates.—These are almost entirely restricted to three great families, viz.: the *Corals*, the *Crinoids*, and the *Echinoderms*.

Of the corals we may mention the *Syringipora ramulosa*, *Cyathozonia cornu*, and one or two forms of *Favosites* and *Cyathophyllum*.

Among the crinoids we have in our collection, *Cyathocrinites planus*, *Pentremites Florialis*, *P. pyramidalis*, and *P. globosus*, from the mountain limestone near Huntsville, Alabama.

4. *Climate of the Coal Period*.—We have seen that the large mass of vegetable remains of the coal formation must be classed among the tree ferns and plants of similar nature. Judging the past by the present, we may draw an inference as to the climate of that remote epoch. *Ferns* and *Lycopodiums* indicate warm climate, equable temperature, and exemption from frost, but not an intensely tropical heat, for ferns are found in New Zealand.

Again, the corals and cephalopods of the mountain limestone are indicative of a warm temperature of the seas, though they by no means imply an ocean warmed by tropical heat.

With regard to the atmosphere, we are warranted in believing that a pure air of oxygen and nitrogen, such as we now have, did not exist. It was highly charged with carbonic acid—unfit for the existence of mammals, but suited to reptiles.

5. *Coal Beds of the United States.*—The coal formation of the United States embraces several coal fields. “The great Appalachian coal field, extending from New York to Alabama, seven hundred and twenty miles in length, covers nearly one hundred thousand square miles. The Illinois coal field, including the western part of the State of Indiana, three hundred and fifty miles long, embraces about fifty-five thousand square miles. Another occurs in Michigan, one hundred and fifty miles long, and covers about twelve thousand square miles. The Missouri and Iowa coal field may be set down at fifty thousand square miles.” The Texas coal field is undetermined. The whole amount to, at least, two hundred and fifty thousand square miles in surface, and three million and a half of cubic miles, solid measure. What an exhaustless source of manufacturing power and commercial prosperity! Can it be equalled anywhere on the face of the globe?

6. *Probable Antiquity, and Mode of Origin.*—It is generally admitted that coal was produced by vegetable decomposition. The formation of a substance very much like coal in the laboratory, and the existence of *lignite* in Tertiary beds, favor this idea. Trees which once grew in great abundance, died, fell to the earth, and underwent decomposition and

bituminization. All the plants we have mentioned thus became imbedded, in the course of these changes, with sand, and mud, and silt, with which the coal strata alternate.

“Nothing is more certain than that all coal was once vegetable. Woody structure may be detected under the microscope; and this, if not in the coal in its ordinary state, at least in the burnt ashes which remain after it has been exposed to the action of heat, and has lost its bituminous and semi-crystalline character.”

The high antiquity of the coal deposits, the lapse of time which occurred during the epoch itself, and the ages which have rolled away since, are all matters of interesting speculation to the geologist.

When we consider the time occupied in the growth of the vegetation, the decomposition of the vegetable matter, the slow deposit in beds, the successive subsidences and upheavals which evidently occurred, we are almost confounded in making any attempt at calculation.

We shall introduce this point again in our chapter on the antiquity of the globe.

7. *Domestic and Commercial Value.*—The value of coal, whether regarded in a domestic or commercial point of view, is incalculable. It is beyond the power of mathematician to estimate in numbers the

advantages conferred upon the whole human family from the simple discovery that *coal is mineral fuel*, and that in burning it yields a gas which may be ignited.

Buried for ages by the hand of the Almighty, it has been exhumed by the hand of man, and brought into useful service for the human race. It glows in the grate, and warms the bodies of millions. It lights the fires of unnumbered village forges, and cheers the heart of the honest mechanic. It feeds the flames of Manchester, and helps to clothe the world. It glitters in the street-lamp, and lightens the path of the evil and the good. It shines in the festive hall, and guides the dancer's step. It lightens the sanctuary, and helps poor mortals to worship their Maker. It lends its heat to water, and moves the wheels of commerce throughout the inhabited globe.

The amount of coal taken annually out of the mines of the world is estimated at *one hundred million tons*. It cannot be exhausted. By an estimate given in Professor Rogers' Report on the Coal-fields of North America, it appears that there are in North America alone about *eight trillion tons*; and in the British Islands, Belgium, and France, about *three hundred billion tons*—to say nothing of the rest of the world, or of mines yet to be discovered. At the pre-

sent rate of consumption (100,000,000 of tons per annum), the coal-fields of Pennsylvania alone would meet the demand for more than 3000 years; and if the consumption were quadrupled, the beds of North America would supply the whole world for 10,000 years.

8. *Moral Reflections.* — Could a narrow-minded, doubting rationalist, have had his existence at the coal epoch, he would have cursed all creation, and pronounced it a miserable failure. Then, “choking down” with carboniferous air, he would have died. Or if he would now limit his view of Providence by an abstract contemplation of life during the times of the coal deposits, he would likely say, “I can beat such a world as this myself. There are no oaks, nor hickories, nor pines, nor poplars, nor cypresses. What could the poor people have done at that time for building material? No beautiful flowers adorn the earth. Surely there were no women; for women and flowers go together.” Just add, “*and no men either, for men and building timber go together.*”

The matter is explained. Man was not yet created. God was yet preparing for him a habitation; and during the long, long epochs of the coal formation, he was kindly providing for his wants, by “laying in” an abundance of bituminous fuel to *do*

him for all the winters of his life — to supply all his forges, to keep up all his gas-works, to propel all his steamboats and steamships, to drive all his manufactures, and to light up all his cities.

A sovereign who would thus provide beforehand for his subjects must be endowed with amazing power, comprehensive wisdom, and exhaustless benevolence.

“Oh, give thanks unto the Lord, for he is good, for his mercy endureth forever!”

CHAPTER XII.

Fourth Period of the Palæozoic Age—The Permian Formation—Great increase of Fishes with Heterocercal Tails.

THE strata which lie in “regular succession” above the coal deposits have been called *Lower New Red Sandstone*, *Magnesian Limestone*, and *Marl Slate*.

The whole group has been named *Permian* by Mr. Murchison, after the ancient kingdom of *Permia*, or *Perm*, in Russia.

“These deposits,” says he, in his work on the geology of Russia, “consist of grits, sandstones, marls, conglomerates, and limestone, sometimes enclosing great masses of gypsum and rock-salt, and are also much impregnated with copper, and occasionally with sulphur, yet *the whole group is characterized by one type of animal and vegetable life.*”

It is evidently the boundary between the Primary Fossiliferous and the Secondary or Mesozoic.

Some of the fossils of the Permian are found in our country (in various regions lying just above coal-beds), but the system or group as described by

the English geologists, is not developed. Perhaps in some of our new territories it may yet be found; but east of the Mississippi river it has not yet been reported. Its largest exhibition is in Russia, between the Ural Mountains and the river Volga; embracing a surface of 280,000 square miles. It is also found in Central Germany and in the north of England. The vertical range is about 1000 feet.

Why is it not found in the United States? Simply because the ocean of that time did not make the deposit here. The ocean was here, lashing its waves all about, in various places, where now the dry land appears; but the fishes of that time did not swim over here. A few molluscs and other inferior animals moved about in our hemisphere, died, and left their remains; but the great mineral deposit, entombing the various animals of the epoch, was made in that part of the world we now call Russia, Germany, and England, and perhaps some other spots, not yet explored. After remaining for ages submerged, it was brought to light by upheaval, and has remained above water ever since.

Fossils of the Permian. 1. *The Flora.*—Sixty species of fossil plants have been found in the Permian strata of Germany, one-third of which are common to the Carboniferous rocks; the remainder seem to belong exclusively to this formation.

The characteristic plants are the *Sphenopteris erosa*, *Sphenop. lobata*, and the *Calamites Gigas*.

Large silicified stems of tree ferns called *Psaronius*, much admired for their beautiful fibre, occur in large quantities in the lower Permian beds of Saxony.

From a careful examination of the plants of this formation and a comparison of their structure with similar forms of the Carboniferous deposits, the ablest geologists of our day have concluded that the *genera* are the same, but the species, with two or three exceptions, are different.

The same remark being applicable to the animal remains, the series of rocks is entitled to a distinct name. Hence it is separated from the coal rocks below, and from the lowest of the Secondary immediately above, and takes its place to mark one of the great periods of the physical history of the globe.

2. *The Fauna*. — It must be borne in mind that at the close of the Carboniferous period there was a great physical revolution, which affected the surface of the earth—a mighty upheaval into separate basins—causing fractures and dislocations. This was general, but not universal. It occasioned the destruction of many genera and species of plants and animals. Where the disturbance did not occur

we may find a number of species of the coal and of the Permian identical.

“The animal remains of the Permian bear a close resemblance to their congeners of the Carboniferous period. The number of species found in Russia, Germany, and England, amount to 230, less than one-fourth of the number discovered in the Carboniferous.”

The *Corals* and *Bryozoa*, twenty-six in number, have the palæozoic type, the small cup-coral *Polycorlia*, apparently showing the quadripartite arrangement of the lamellæ characteristic of the cup-corals of the old rocks. The abundant *Fenestella retiformis* reminds us of the primeval fauna. *Crinoids* are rare.

The *Brachiopods*, of which about thirty-eight species are known, offer many *Producti* analogous to those of the coal period. Eleven species of *Spirifer* occur, one of which, *Spir. Undulatus*, is the most characteristic, and *Sp. crustatus* is supposed to be common to the Carboniferous and Permian rocks. Of the genus *Orthis*, which prevails so greatly from the Silurian to the Carboniferous, inclusive, we here find no trace; nor does it occur in any superior formation. Two or three species of *Terebratula* are very abundant. The genus *Pentamerus*, abundant in

the Silurian, Devonian, and Carboniferous, has not yet been detected in the Permian deposits.

The *Cephalopods*, which, under the forms of *Nautilus*, *Orthoceras* and *Goniatites*, were so numerous in the preceding formation, became almost extinct before the introduction of the Permian. Trilobites are entirely wanting. With the final extinction of this family, its place is taken by an allied crustacean, the *Limulus*, the earliest form of which was created during the coal, and has survived all the revolutions which have followed its creation. The genus still exists.

The fossil fishes of this era, of which fifty-three species are known, all belong, like their precursors, to the division with *heterocercal* tails — a distinction that becomes more and more evanescent in all the succeeding formations, and in our era is confined to the shark and sturgeon families — all other species, nearly 8,000 in number, having *homocercal* tails.*

The *Palæoniscus*, *Pygopterus*, *Cælacanthus*, *Acrolepis*, and *Platysomus*, the prevailing genera of the

* The *Heterocercal* fishes are all those which have their tails unequally bilobate, and the vertebral column projected into the upper caudal lobe. The *Homocercal* are those which have the tail fin single or equally divided, and the vertebral column is not extended into either lobè. — *Agassiz*.

Permian period, are all found in the Carboniferous epoch, *but the species of the Permian are wholly distinct.*

In all of these the back-bone is prolonged with a bend into the end of the upper lobe of the tail. The "development" of fishes since that period has not been upward.

In the last place, we notice the *Thecodont Saurians*. These saurians are distinguished by having the teeth deeply implanted in the jaw-bone, and in distinct sockets, instead of being soldered, as in frogs, to a simple alveolar parapet. Two of these have been described, viz. : the *Paleosaurus*, and *Protosaurus*. They are allied to the living monitor, and exhibit marks of a high and complex organization. Here again the doctrine of development finds refutation. Observe, that in one of the oldest formations of the globe, we find lizard-like animals, which occasionally walked on dry land, possessing an organization which places them on a level with highly developed lizards of the present age. Mr. Owen, the great comparative anatomist, who, to some extent, imbibed the views of the Lamarkian school, acknowledged, twenty years ago, that these Saurian reptiles in the Permian rocks did not sustain the idea of development of reptiles from fishes, or from simple to more complete forms.

We have thus reached the close of the Palæozoic age. We close one grand volume of the world's history, and are ready to open another.

In our upward passage through the fossiliferous rocks, we must now take leave of all the true primary forms, and begin the examination of those living forms that characterized the middle ages.

CHAPTER XIII.

First Period of the Mesozoic Age—Batrachian Reptiles—Ferns, Cycads, and Conifers—Liassic and Triassic Formations.

THE close of the Palæozoic age introduced a new era; and it was ushered in by the artillery of volcanos and the sound of many waters—dislocation of strata, depressions or vast subsidences beneath the ocean, destruction of plants and animals, and the creation of new species to take their places.

Henceforth we are invited to study, in order, the Secondary formations—beginning with the lowest and proceeding in ascending series, as heretofore.

The first of these, reposing on the Permian, in regular chronological order, is the *Trias*, sometimes called the Upper New Red Sandstone. It may rest on any sub-Permian formations or upon the igneous rocks. The following table shows its position :

England.	Germany.	France.
a. Saliferous and gypseous } shales and sandstone. }	Keuper.	Marnes irisées.
b. Wanting.	Muschelkalk.	Muschelkalk.
c. Sandstone and quartz } are conglomerate. }	Bunter Sandstein.	Gres bigarré.

The *Bunter Sandstein* in Germany, or, in plain English, the variegated sandstone consists of various colored sandstones, dolomites, and red clays, and often presents a vertical range of 1,000 feet. It contains fossil plants and marine shells.

The *Muschelkalk* is a compact greyish limestone, including beds of dolomite, gypsum, and rock salt, and contains remains of radiata, shells, and fishes.

Vertical range, 1,000 feet.

The *Keuper* consists of sandstones, gypsum, carbonaceous slate, clay, and saliferous marls of various colors.

It contains remains of reptiles and fish, also ferns, equisetaceous plants, cycads, and conifers.

Vertical range, 1,000 feet.

These are the three divisions of this system. Hence the name Trias. The Bunter Sandstein is the lowest, the Muschelkalk is the middle, and the Keuper, the upper or newest.

Let us arrange them in this manner:

Upper Trias.	Various colored marls with Gypsum.	Keuper.
Middle Trias.	Compact grey and greenish limestone, with dolomite and gypsum. }	Muschelkalk.
Lower Trias.	Variegated sandstone, dolomite, and red clays. }	Bunter Sandstein.

Fossils of the Lower Trias.—Thirty species of ferns,

cycads, *conifers*, and other plants have been enumerated from this division of the Trias by European geologists. All of them seem to belong to this part of the system — at least, they have not as yet been discovered in the upper and middle member.

But the most remarkable organic relics of this portion of the earth's crust are the *footprints* and fragments of bones of several animals of different species.

The first we shall notice has been called the *Labyrinthodon*, from the fact that its tooth, upon close microscopic examination, exhibited a most beautiful labyrinthine structure, not unlike the windings of the surface of the brain.

This animal was an immense *Batrachian*—an enormous frog-like creature. One of its teeth measures three and a half inches in length by one and a half in breadth, at the base. Its head, as large as a big alligator's, and its pelvis, corresponding in size, indicate an animal of formidable size, for a toad or frog; and of one thing we are quite certain—that, although it has passed away, and we never shall hear its loud and deafening bellow, it has “left its footprints on the sands of time.” These sands have become hardened, and the *ichnolite* is imperishable.

From the structure of the nasal cavity, it is inferred that this huge batrachian was an air-breather

—the posterior outlets being at the back part of the mouth, and not under the anterior or external nostrils.

The footmarks it has left were probably imprinted on the shore of the ocean; for they could not have been made by an animal walking under water.

We notice, next, the remarkable footprints of the Connecticut Valley. The following is Dr. Hitchcock's description of a slab of rock taken from Turner's Falls:

"It exhibits four rows of a biped, or bird, one row of a quadruped, whose hind-foot was the largest, and two rows of what is supposed to be the track and the trail of a tortoise. The whole slab is covered also with rain-drops, which fell after the tortoise had passed over the mud, but before the passage of the other animals. The joints of the toes are distinctly manifest in the bird-tracks."

Dr. Hitchcock states that no less than thirty-two species of bipeds, and twelve of quadrupeds, have been discovered in these rocks of the Connecticut Valley—thirty of birds, four of lizards, two of che-lonians, and six of batrachians. The tracks have been found in some twenty or thirty different places, extending up and down the valley nearly 100 miles; and they are repeated through a succession of beds 1000 feet thick. The bird-tracks were made

by birds two, three, and four times as large as the ostrich.

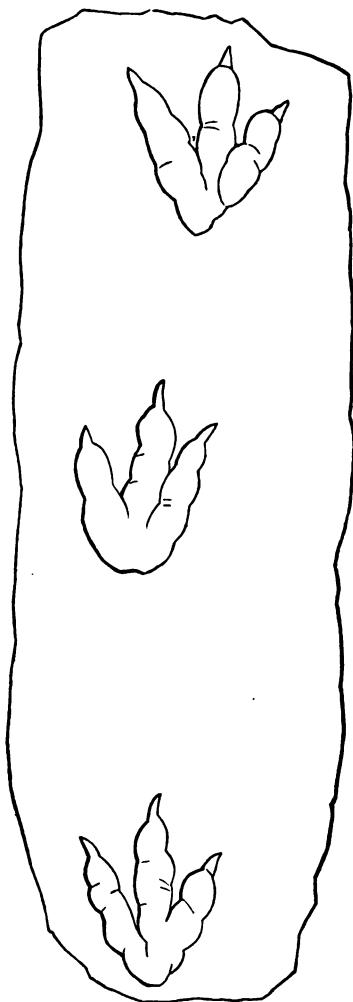
There were giant frogs, and lizards, and birds in those days. The simple narrative of a geologist, detailing absolute facts, appears, to one unaccustomed to the sight of a lizard longer than his hand, or a frog larger than his fist, as a second edition of "Gulliver's Travels;" but we have only to ask all such sceptical persons to examine for themselves.

Just make out a little statement in the rule of three, like the following, and then lay your scepticism aside.

As the middle toe of a chicken's foot is to the middle toe of a turkey's foot, so is the size of a chicken to the size of a turkey.

The middle toe of a full-grown chicken, we will say, is an inch and a quarter long; the middle toe of a turkey is two inches and a half. Then twice the length of toe indicates at least twice the size of bird.

Now the middle toe of an ostrich is about four or five inches long—say five inches. The toes of some of the birds—or, rather, the prints of the toes—in the Triassic sandstone of the Connecticut Valley, were 20 inches. It follows that the birds that made these tracks were four times as large as a common ostrich.



Tracks of Brontozoum Giganteum.

The discovery of the skeleton of the *Dinornis*, a wingless bird of New Zealand, which must have been 12 feet high, confirms this view.

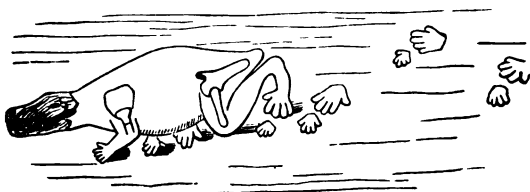
Fossils of the Middle Trias. — The Middle Triassic group of rocks is not found in England or America. It is developed in France and Germany. The Flora consists of *Equisetites* and *Calamites*. The Fauna embraces a few *Cephalopods*, some bivalve shells, and a great abundance of lily *Encrinites*.

Fossils of the Upper Trias. — The plants of the Upper Trias consist of ferns, equisetaceous plants, cycads, and conifers. Remains of reptiles, called



Lily Encrinite

Nothosaurus and *Phytosaurus*, have been found in it; also parts of the *Labyrinthodon*. The detached teeth of placoid fish have also been found.



Labyrinthodon Paehygnathus.

The Lias or Liassic System.—This formation is found in England, France, and Germany, and probably in Asia and South America; but it is wholly absent in the United States.

It consists mostly of aluminous shales, calcareous clays, sands, and argillaceous limestones, and is exceedingly rich in fossils, especially animal remains.

Vertical range, about 600 feet.

Position, immediately above the Trias.

It takes its name from the aspect of its beds, in riband-like *layers*.

Fossils. The Flora.—Forty-seven *Acrogens* have been enumerated by the great fossil botanist, M. Ad. Brongniart,—most of them ferns,—and fifty gym-nogens, of which thirty-nine are cycads and eleven conifers. Petrified wood, in various sizes, is found in abundance.

“That some of this wood,” says Mr. Lyell, “was soft when it first lay at the bottom of the sea, is shown by a specimen now in the museum of the

Geological Society, which has the form of an *ammonite* indented on its surface."

The Fauna.—This formation is one of the richest in animal remains that explorers have discovered.

Three of the grand divisions are more beautifully represented than in any older formation.

The radiated is represented by encrinites.

The molluscos, by handsome ammonites.

And the vertebrated, by large fishes and reptiles.

Beginning with the radiata, we may observe that corals are not numerous—indeed, they are very rare; probably because the muddy beds of the ocean were not favorable to coralline life. But there was an abundance of *Crinoids*.

The most remarkable of these was the *Pentacrinite*—an animal which had a skeleton of one hundred and fifty thousand pieces.

"The stem was five-sided, and the body was partly defended by a small cup, formed of regular plates, rising from the column, and partly enclosed by a multitude of very minute and angular plates, fixed on a tough, membranous pouch, terminating with an extensile proboscis. The body was surrounded also by an incredible number of branching arms, forming a complicated stony net-work, intended to intercept and convey to the stomach the particles of food fit for the animal, which were floating in the water within reach."

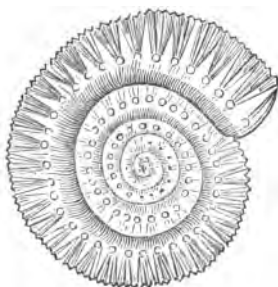
We find, also, in this formation, a number of star-fishes, of which we cannot speak particularly.

We must notice in a special manner the molluscous animals.

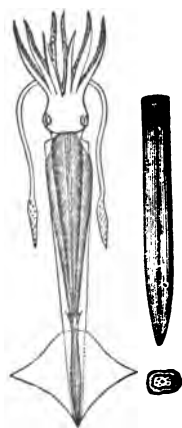
The *Terebratulæ* are found here; the *Gryphoea Incurva*, allied to the oyster; the *Nautilus*, the *Belemnite*, and the *Ammonite*—the last three belonging to the *Cephalopods*.



Gryphæa Incurva.



Ammonite.



Belemnite.

The *Ammonite* is allied to the *Nautilus*, and the latter is our guide in forming a proper estimate of the character of the former.

The best description of these chambered shells, with accompanying illustrations, is found in Dr. Buckland's *Bridgewater Treatise*. From the late edition we make the following abridgement:

"The Nautili constitute a natural genus of spiral discoidal shells, divided internally into a series of chambers that are separated from each other by transverse plates; these plates are perforated to admit the passage of a membranous tube or siphuncle, either through their centre or near their *internal* margin.

"The external open chamber is very large, and forms the receptacle of the body of the animal. The internal close chambers contain only air, and have no communication with the outer chamber, except by one small aperture in each plate for the passage of a membranous tube, which descends through the entire series of plates to the innermost extremity of the shell.

"These air-chambers are intended to counter-balance the weight of the shell, and thereby to render the body and shell together so near the weight of water, that the difference arising from the siphun-

cle being either empty or filled with a fluid, may cause the animal to swim or sink.

“These chambers are filled with air, and must be exposed to great pressure when at the bottom of the sea.

“Several provisions are made in order that they may endure this pressure.

“The shell is constructed upon the principle of the *arch*, and the arch is fortified by minute *ribs* externally and firm *transverse plates* internally.

“The mechanism of the *siphuncle* is very remarkable. It terminates in a sac surrounding the heart. This sac contains a pericardial fluid, and this fluid changes places from the pericardium to the siphuncle and back. Here, then, is an hydraulic apparatus for varying the specific gravity of the shell, so that when it sinks the pericardial fluid is forced into siphuncle, and becomes buoyant when the same fluid returns to the pericardium. This is the same principle which regulates the ascent and descent of the water-balloon.

“An Ammonite, like a Nautilus, is composed of three essential parts; 1st. An *external shell*, usually of a flat discoidal form, and having its surface strengthened and ornamented with ribs. 2d. A series of *internal air-chambers* formed by transverse plates, intersecting the inner portion of the shell.

3d. A *siphuncle* or pipe, commencing at the bottom of the outer chamber and thence passing through all the chambers to the innermost extremity of the shell.

“Externally, we find all the mechanical advantages which appear to be necessary — the *arch*, the *ribs*, the *flutings*, and the *bosses*; and internally, the *transverse plates* serving as supports to resist the inward pressure of the sea upon the shell, together with the siphuncle designed to regulate the specific gravity of the shell and its inhabitant.”

We are led to infer that the Ammonite floated on the surface of the sea as the Nautilus does now, and that it sank and rose in water by the power of adjusting the hydraulic apparatus of the *siphuncle*.

Are we not bound to conclude that, as in the works of man, an excellent design shows a skilful designer or architect, so in the case of the Ammonite there is a design running through countless ages, and that the structure and functions of all cephalopods inhabiting chambered shells, form a part of the great argument for the existence of one God?

The next cephalopod which attracts our attention, is the *Belemnite*, a chambered shell often found in the Lias.

It has been shown that the animal possessed not

only an internal chambered shell, but was provided with a row of hooked arms, muscular mantle, fins, and ink-bag (like the cuttle-fish.) It could swim backwards and forwards, rise rapidly, claw a fish, and dart down speedily to the bottom of the sea and devour its prey. At the approach of an enemy it could eject its inky fluid and conceal itself in darkened water, until its pursuer would be tired out hunting for it.

Ammonites and *Belemnites* are characteristic of the Lias. They abounded in a tolerably deep sea with a muddy bottom. They are also found in the rocks above the Lias, and may be regarded as the most prominent representatives of the middle ages, from their division of the animal kingdom.

Passing on to the vertebrated animals, we must pay attention, 1st, to the *fishes*, and, 2d, to the *reptiles*.

The fishes belong to extinct genera, having enamelled scale and bone, ranking among the *Placoid*.

The *Dapedius* was common. It had a wide, flat, broad body, covered with large and nearly square scales coated with enamel — short jaws — the lower are broad and high—the fore-part depressed towards the middle to receive the upper jaw. These bones and the entire palate were thickly covered with teeth.

The *Pachycormus*, of which there are nine species, attained to a considerable size, and was well supplied with rows of sharp and powerful teeth.

Two or three remarkable *Rays* are found in the Lias.

From a view of the encrinites, crustaceans, molluscs, and fishes of this deposit, as exhibited in England, it appears, says Professor Ansted, "that it took place in a great bay like the Yellow Sea, with land at no great distance, the resort of a vast number of such animals as commonly inhabit localities of that kind, and also of the predatory races that pursue and devour them."

We come, in the last place, to notice the reptiles. It has been called an age of reptiles.

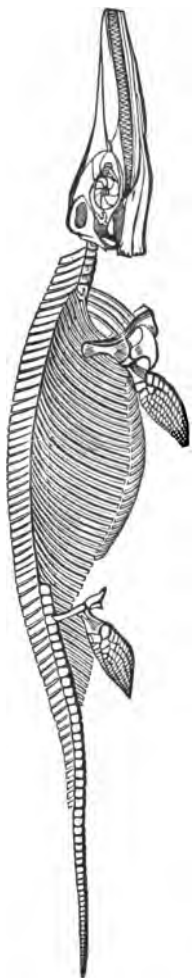
The most distinguished of these were the *Ichthyosaurus* and *Plesiosaurus*.

We will first notice the *Plesiosaurus*.

The name is derived from the Greek *plesion*, resembling, and *sauros*, a reptile.

Its characteristic was an enormously long neck. From specimens preserved, it is quite certain that it included between thirty and forty vertebræ. The whole animal was about twenty feet in length. Its head was like a lizard's—its tail like a crocodile's, and its paddles like those of a fish.

The *Ichthyosaurus*, or Fish Lizard, resembled the



Skeleton of Ichthyosaurus.



Skeleton of Plesiosaurus.

Porpoise. It had a skin like a whale, tail and fins like a fish, and the head of a crocodile.

“Imagine then one of these monstrous animals, a *Plesiosaurus*, some sixteen or twenty feet long, with a small wedge-shaped crocodilian head, a long arched serpent-like neck, a short compact body, provided with four large and powerful paddles, almost developed into hands; an animal not covered with brilliant scales, but with a black slimy skin. Imagine for a moment this creature slowly emerging from the muddy banks, and half walking, half creeping along, making its way towards the nearest water. Arrived at the water, we can understand from its structure that it was likely to exhibit greater energy. Unlike the crocodile tribe, however, in all its proportions, it must have been equally dissimilar in habit. Perhaps, instead of concealing itself in mud or among rushes, it would swim at once boldly and directly to the attack. Its enormous neck stretched out to its full length, and its tail acting as a rudder, the powerful and frequent strokes of its four large paddles would at once give it an impulse, sending it through the water at a very rapid rate. When within reach of its prey, we may almost fancy that we see it drawing back its long neck as it depressed its body in the water, until the strength of the muscular apparatus with

which this neck was provided, and the great additional impetus given by the rapid advance of the animal, would combine to produce a stroke from the pointed head which few living animals could resist. The fishes, including perhaps even the sharks, the larger cuttle-fish, and innumerable inhabitants of the sea, would fall an easy prey to this monster.

“But now let us see what goes on in the deeper abysses of the ocean, where a free space is given for the operations of that fiercely carnivorous marine reptile, the *Ichthyosaurus*. Prowling about at a great depth, where the reptilian structure of its lungs and the bony apparatus of the ribs would allow it to remain for a long time without coming to the air to breathe, we may fancy we see this strange animal, with its enormous eyes directed upwards, and glaring like globes of fire ; its length is some thirty or forty feet, its head being six or eight feet long ; and it has paddles and a tail like a shark ; its whole energies are fixed on what is going on above, where the Plesiosaurus or some giant shark is seen devouring its prey. Suddenly, striking with its short but compact paddles, and, obtaining a powerful impetus by flapping its large tail, the monster darts through the water at a rate which the eye can scarcely follow towards the surface. The

vast jaws, lined with formidable rows of teeth, soon open wide to their full extent; the object of attack is approached — is overtaken. With a motion quicker than thought the jaws are snapped together, and the work is done. The monster, becoming gorged, floats languidly near the surface, with a portion of the top of its head and its nostrils visible, like an island covered with black mud, above the water.

“Such scenes as these must have been every day enacted during the many ages when the waters of the ocean were spread over what is now land in the Eastern Hemisphere, and when the land then adjacent provided the calcareous mud now forming the Lias.”

CHAPTER XIV.

Second Period of the Mesozoic Age. — Wealden and Oolite Formations — Period of Enormous Land Reptiles — Mammalian Animals first introduced.

NEXT in order above the Lias, we find the Oolite. The rocks of this formation embrace clays, shales, limestones, and sandstones. It is largely developed in England and in the Jura mountains. It derives its name from the round egg-like nodules found in many of the limestones of the formation. Oolite limestone is found in abundance in other groups, as, for example, in the Carboniferous, but the distinctive name Oolite has been appropriated to this one.

In our country there is a small deposit near Richmond, Virginia, which, from its fossils, etc., has been pronounced Oolite by very competent judges. It contains coal.

Fossils.—The *Flora* of the Oolite was rich and beautiful. It consisted of cycads, conifers, ferns, and palms.



a b c d e
a Palm. b Arborescent fern. c Cycas. d Pandanus. e Zamia.

The cycads were very abundant. Some of them were short, stumpy, cylindrical, scaly stems, with large, fern-like looking leaves. Others were large, having trunks thirty feet long.

Lignites and coal are found in the Oolite beds of Europe; but the largest coal-beds of this formation are at Richmond, Virginia.

The Fauna.—All the divisions of the animal kingdom were represented here.

Of the *Radiates*, we find corals in reefs; as the Coral Rag of England, aculephs, crinoids, and starfishes. Among the corals we find the *Caryophyllia annularis* and the *Astrea*; and among the crinoids was the *Pear Encrinite*.

The *Molluscs* were very abundant, and they were exceedingly beautiful.

Ammonites and *Belemnites* appeared in all their beauty. They were the gems of the ocean.



Ammonites Jason.



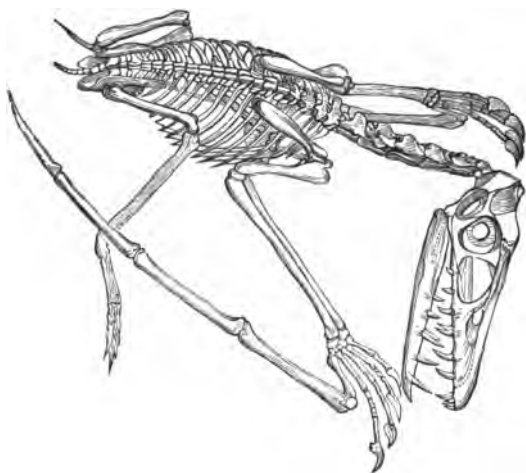
Belemnites Hastatus.

Articulates existed in the form of crustaceans and insects. Their remains are found in clay. The entire exterior of a lobster-like animal is found, and the remains of insects very much like the dragon-fly have been preserved, even to the nerves of the wings.

Vertebrates.—Reptiles and fishes shared the Oolitic ocean with the other animals of which we have spoken.

Of the reptiles, the most prominent were the *Ichthyosaurus*, *Plesiosaurus*, and *Megalosaurus*. The most remarkable was the *Pterodactyle*.

This creature had the wings of a bat, the head of a crocodile, and the body of a mammal. It could walk, fly, or swim, according to inclination or emergency.



The Pterodactyle.

The fishes of the Oolite are principally ganoids.
The mammals appear to have resembled the opos-

sum and kangaroo. Several specimens of the lower jaws of such quadrupeds have been found. Two distinct genera have been defined, to which the names *Amphitherium* and *Phascolotherium* have been given.

The *Wealden range* is interesting, from the fact that the deposits are fresh-water.

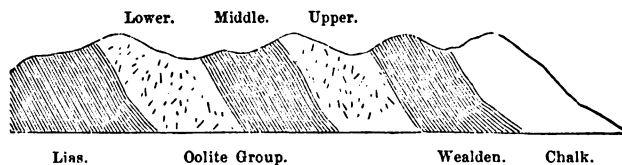
The relative order of the beds, as reported by English geologists, is as follows:

1. Weald Clay, with some Limestone and Sand. Fresh-water Shells.
2. Hastings Sand — Sandstone, Conglomerate, and Lignite. Fresh-water Shells.
3. Purbeck Strata. Limestone and Clay, alternating, resting upon Oolite.

The whole amounting to 1000 feet in thickness.

It is found in Great Britain, France, and Germany, but does not appear in the United States.

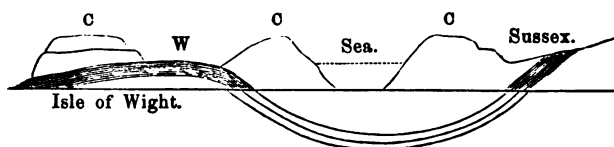
It takes its name from the old word *wealds*, which means woods; being largely developed, and first noticed in the forests of Kent and Sussex.



This figure presents to the eye the relative positions of the Lias, Oolite, Wealden, and Chalk.

The Lias underlies the Oolite, the Oolite underlies the Wealden, and the Wealden underlies the Chalk.

Here, then, is unquestionable evidence of a fresh-water deposit underlying a deep sea deposit—showing subsidence and upheaval of a slow character; for there are no marks of violence.



This diagram shows how the Wealden appears as a surface formation on the Isle of Wight, its normal position under the Chalk, its dip under the sea, and its reappearance in Sussex, England.

The fossils of the Wealden are, for the most part, either fresh-water or terrestrial. Some few are marine, and similar to the Oolite.

Flora. — The lower portion of the Wealden, resting on the Oolite, contains a “dirt-bed,” in which are found vestiges of the *Zamia* and *Cycas*, and silicified trunks of coniferous trees. The stumps of trees stand erect, from one to three feet high — an example of a submerged forest.

Fauna. — It is remarkable that there are no Corals, Encrinites, Brachiopod shells, Belemnites, or Am-

monites—in a word, no marine animals of consequence; but the fauna was evidently composed of fresh-water and land animals.

The *Molluscs* included several species of *Melania*, *Paludina*, *Cyrena*, *Cyclas*, *Unio*, and *Cyprara*—all river and lake species.

There are a few brackish water-beds, in which marine shells, such as are found in gulfs, have been discovered.

The *Vertebrate* animals embraced fishes and reptiles. The fishes were similar to the carp; having large rhomboidal scales, covered with enamel. They were river fish, and never went out into the sea.

But the most remarkable animal remains of the Wealden are the prodigious reptiles.

To say nothing of the large turtles, and various Saurians, of species similar to those of the Oolite, we must not fail to notice particularly the gigantic *Iguanodon*, discovered and described by Dr. Mantell. Its remains are numerous, and they have been carefully examined by a number of comparative anatomists. The reader is referred to Buckland's "Bridge-water Treatise," and to Dr. Mantell's "Wonders of Geology," for a full description of this terrible land-lizard. We can present only a very brief outline, compiled from these excellent authorities.

It was an herbivorous animal—at least, so say its teeth.

The whole length, from snout to tail, varied from thirty to sixty feet; and its entire anatomical structure shows that it was intended to move on land.

It lived upon the vegetables that grew upon the land where it walked. The remains of these vegetables are found in the strata enclosing the animal.

It had no occasion to go to the sea; and, being an air-breather, it could not have lived in the sea.

It was fitted for the land, and the land was suited to its wants.

CHAPTER XV.

Third Périod of the Mesozoic Age — The Cretaceous Formation.

THE Cretaceous formation comprises a series of beds, all containing marine fossils. It is, therefore, considered a marine formation.

It takes its name from the prominent character of one of its members — the chalk.

It embraces, besides chalk, sands, sandstones, marls, and clays.

The pure chalk is sometimes absent; but notwithstanding this, the remaining members of the group are called, for convenience, Cretaceous.

There is just one infallible method by which we are able to determine the cretaceous character of any marls, sands, etc., in the absence of the real chalk. That method we have already laid down. *Look at the fossils.*

The Cretaceous formation is found all over Europe, in Northeastern Africa, in India, in South America, and in the United States.

In our country the pure chalk has not been found;

but other members of the series have been discovered in the Atlantic and Southern States, and in some of the Northwestern Territories.

This system of rocks has been divided into Upper and Lower Cretaceous.

The *Upper* division embraces in order,

1. Limestone.
2. White Chalk with Flints.
3. White Chalk without Flints.
4. Upper Greensand.
5. Gault; or dark-blue Marl.

The *Lower* division embraces,

1. Sand, Yellow and Red.
2. Sand, Green.
3. Calcareous Stone.

Chalk is an earthy carbonate of lime, and may be tested by acids (nitric, muriatic, or acetic). If effervescence occurs, it is chalk; if not, your white, chalky-looking earth is white clay.

Gault is a stiff, dark-blue, clayish substance, sometimes compact and hard; and when it contains carbonate of lime, it may be regarded as a species of marl.

Greensand is sand colored by silicate of iron.

Fossils.—The vegetable and animal remains of the Cretaceous rocks indicate a wide, deep sea.

The *Flora* was not very luxuriant. We may re-

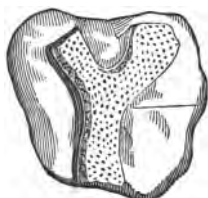
mark, however, the *first appearance* of *Exogens*, which in after times became abundant, and which now constitute a very large majority of living plants—such as the forest oaks, hickories, etc., together with garden shrubs. Tree ferns are still existing. The remains of one were found in the south of France some years since. This fact indicates considerable change of climate.

Most of the plants were sea-weeds.

The Fauna of the Cretaceous Period.—No bones of land animals have been found, and no land or river shells; but we find corals, sea-urchins, marine shells, fishes, and reptiles.

We may arrange them as follows:

Radiates. { Corals. Eschera Disticha. Spongia.
Sea Urchin. Ananchytes Ovata. Spatangus.



Eschera Disticha.
(Coral of White Chalk.)



Ananchytes Ovata.
(Urchin of White Chalk.)

Molluscs.—The *Cephalopods* were abundant.

The Belemnite, Ammonite, Baculite, and Turrilite all left their calcareous houses, and collectors in all parts of the world are now gathering them in.

The *Brachiopods* flourished in the form of *Terebratulæ*.



Belemnitella Mucronata.



Ammonites Nebrascensis.



Baculites Ovatus.

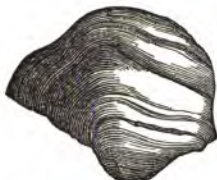


Terebratula Octoplicata.

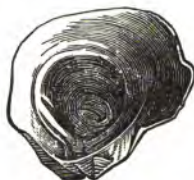


Terebratula Defranca.

We find also the oyster and the pecten.



Ostrea vesicularis. *Grayhæa globosa*, Min. Con.
Upper chalk and upper greensand.



Pecten 5—costatus.
White chalk, upper and lower greensands.

Vertebrates. — Fishes and reptiles were the only representatives of vertebrated animals.

It must be noticed that here, for the first time in the history of fishes, we meet with *Ctenoids* and *Cycloids*. Up to this period, and from the Lower Devonian, all the fishes belong to the *Placoids* and *Ganoids*.

The *Ichthyosaurus* and *Pterodactyle* were prolonged to this period, and in addition thereto we find the *Mosasaurus*, a reptile 25 feet long, which lived and died out in the cretaceous seas. It was allied to the monitor of the present period. It was found at Mæstricht, and now adorns the museum of Paris.

The reign of large reptiles closed with the Cretaceous period.

And thus closes our account of the third period of the Mesozoic age.

We must open another volume, after a few general remarks touching the physical geography of the age we have just passed over. It appears that during a greater part of the age, there was very little violent disturbance of a general character. There is scarcely a vestige of volcanic action anywhere on the continent of Europe, and none with which we are acquainted in the United States, among the Cretaceous deposits—and only such evi-

dences of volcanic outbursts in the Lower Secondary rocks, as are consistent with cotemporary life and enjoyment—such indeed as we now discover in various parts of the habitable globe.

The bed of the ocean, as in every period, underwent depressions and upheavals, slow and sure ; and it is probable that at the close of the Secondary period, great disturbances occurred, connected with the elevation of Europe and Asia.

CHAPTER XV.

First or Earliest Period of the Kainozoic Age—The Eocene Tertiary—
Period of the Pachyderms of the Paris Basin.

WE now arrive at the Tertiary formation—the Tertiary period, or, as it is often called, the *Kainozoic* age. The reader will remember that this term, *Kainozoic*, means recent life, and indicates the beginning or dawn of animal and vegetable forms, similar in nature to those which now exist.

We see this similarity in the exogenous trees and plants,—in the mammalian animals,—in the ctenoid and cycloid fishes,—in the marine shells, and in the corals. At the same time we have to remark the extinction of those enormous Saurians which existed in the middle periods, and the rapid decline of Heterocercal fishes.

The Secondary period is cut off from the Tertiary in its characteristic features—organic remains. Very few species of the one can be found in the other. New genera of vegetables and animals de-

clare a new creation — a distinct manifestation of creative power.

Whether the species of the former period were destroyed suddenly by violent disturbances, or whether they “died out” gradually, has been a question for discussion. We are inclined to the lat-

The subdivision of the Tertiary deposits by Mr. Lyell, has been universally adopted. He arranges the whole into three great divisions, each one of which he subdivides for convenience of description, as well as to indicate with accuracy the chronological order of deposit.

The lowest division he styles EOCENE, (*eos*, dawn, and *cainos*, recent,) a word which signifies dawn of the recent; and the fossil shells of this period contain a small proportion of living species.

The middle division he calls MIOCENE, (*meion*, less, and *cainos*, recent,) a term which conveys the idea of a minor proportion of recent species (of shells.)

The upper division he names PLIOCENE, (*pleion*, more, and *cainos*, recent,) which indicates that the fossil shells of this division contain a plurality of modern or recent species.

The following view presents to the eye the natural order of the Tertiary strata.

3. Upper or Pliocene. Contains a plurality of recent species.
2. Middle or Miocene. Contains a minor proportion of recent species.
1. Lower or Eocene. { Contains a very small proportion of recent species.

Tertiary deposits are found in abundance in all parts of Europe, except Russia—throughout Asia and South America. In the United States they may be distinctly traced from New Jersey to Texas along the coast, and for some distance in the interior. More than nine-tenths of the State of Mississippi belongs to the Tertiary. The Cretaceous formation appears at the surface in the eastern part of the State, but soon dips under, passing westward under the Mississippi river.

The rocks of the Tertiary formation are limestones, sandstones, marls, clays, and gypsum, usually in the form of selenite.

Volcanic rocks are found penetrating the strata. We have picked up obsidian in several places in Southern States, and have often noticed tons of ferruginous sandstone that bore evident marks of fusion.

Fossils.—The *Flora* and *Fauna* are both deeply interesting. It is remarkable, that while a large portion of the vegetable remains has undergone bituminization or petrification, a majority of the shells lie almost unchanged, and nearly all the large

bones retain so much of their original osseous character, that they scarcely deserve the name of petrification.

Flora.—During the Miocene era of the Tertiary period there were many conifers, the remains of which, having undergone bituminization, constitute the masses of lignite or brown coal so frequently found in all the Tertiary strata. This substance is almost worthless.

The sandstones of the Miocene also contain a great quantity of dicotyledonous plants, in a silicious state. Leaves also are found in clays and marl-beds, bearing very close resemblance to the leaves of existing walnuts, maples, elms, and birches.

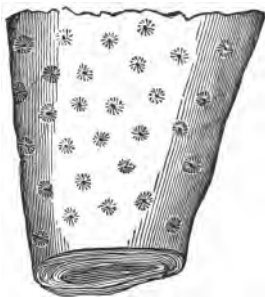
The remnants of palm-trees lying scattered through the Tertiary sands, show the existence of monocotyledonous plants during that period. Fragments weighing several hundred pounds are often found in the South.

Fauna.—*Fossils of the Eocene.*—The Eocene Tertiary contains a greater variety of fossil remains of animals than any other with which we are acquainted. Mammals, birds, reptiles, fishes, shells, insects, crustaceans, corals, and sea-urchins, are found in profusion in many localities; though we must apprise the reader that he cannot find them all piled up together in a confused mass.

We have gathered from one place some twenty or thirty species of bivalve, and many of univalve shells, while from another we could get nothing but corals and sea-urchins. In a third locality we could obtain remnants of fish and fish only; in a fourth, oysters.

We will notice them in order.

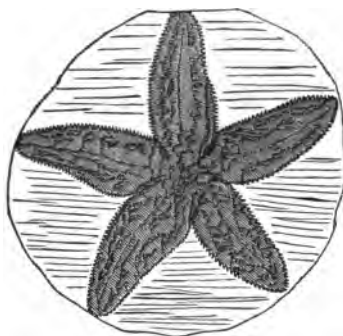
Radiates.—Corals are abundant; and among others the *Madrepore* is a good representative.



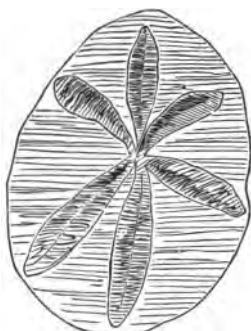
Madrepora Palmata. Eocene, Mississippi.

We find, also, *Asteroids*, or star-fishes, and *Echinoids*, or sea-urchins, and the like.

Molluscs.—The *Cephalopods* of former epochs had disappeared; and now the *Brachiopods*, *Gasteropods*, etc., swarmed the seas. New species made their appearance; some of which, as we now discover by comparison, bear a close resemblance to existing forms.



Asteroid. Hinds Co., Miss. Eocene Limestone.



Spatangus. An Echinoid of Eocene Limestone. Hinds Co.

We have gathered large quantities of the following from various localities in the South—principally from Vicksburg and Jackson, Mississippi, and Claiborne, Alabama. The last-mentioned place affords more than four hundred species of marine shells.

- | | |
|-------------------------|------------------------------|
| 1. Ampullaria Acuta. | 18. Natica Permunda. |
| 2. Astarte Paralis. | 19. Navicula Aspersa. |
| 3. Bulla. | 20. Mitra (5 or 6 species). |
| 4. Cardium Nicoletti. | 21. Ostrea Trigonalis. |
| 5. Cardium Porulosum. | 22. Pectunculus. |
| 6. Cytherea. | 23. Pleurotoma. |
| 7. Crassatella Salcata. | 24. Rostellaria Vellata. |
| 8. Crithium Minimum. | 25. Rostellaria Extenta. |
| 9. Cornus Tortilus. | 26. Terrebellum Fusiforme. |
| 10. Cassis. | 27. Turritella Imbricatena. |
| 11. Cyprea Fenestratis. | 28. Turritella Alveata. |
| 12. Copulus Americanus. | 29. Trochita Alta. |
| 13. Cardita Planicosta. | 30. Voluta Athleta. |
| 14. Dentalium. | 31. Murex. |
| 15. Eburna. | 32. Solarium. |
| 16. Flabellum. | 33. Venericardia Planicosta. |
| 17. Nucula. | |

*Ampullaria Acuta.**Cardium Porulosum.**Crassatella Sulcata.**Terrellum Fusiforme.**Turritella Imbricataria.*

Besides these marine shells, a number of fresh-water shells have been found — such as the *Lymnea* and *Planorbis*.

The small microscopic shells, designated *Nummulites*, belong to the Eocene Tertiary.

Mammulike limestone is abundant in the Alps. The entire rock appears to have been formed from the shelly covering of these minute testaceous animals. A great part of Paris is built of this limestone.

Articulates.—*Crustaceans* and *Insects* are found, but their remains are not extensive. Insects have been found in the fossil amber of New Jersey—showing clearly that they were entangled and imbedded when that material was in a fluid state.

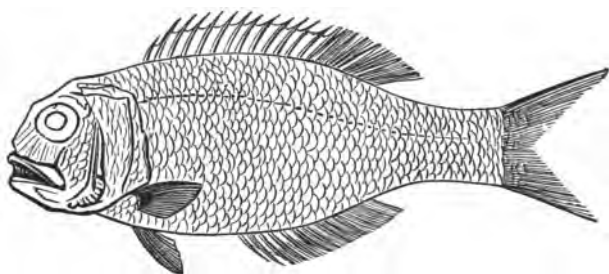
Vertebrates.—We will notice the fishes first.

Eocene fishes may be distinguished into groups. They belong in part to the Ctenoid and Cycloid orders (allied to modern fishes), and partly to the ancient Ganoid and Placoid orders. All the species of Eocene fishes are extinct, but several of the genera are still living.

Of one hundred species of fossil fish from the London clay (Eocene), examined a few years since, about one-half were referred to genera of the Ctenoid and Cycloid orders, and the other half to the Ganoid and Placoid.

“Among the principal families of fish represented in the Eocene of London, are those of which the Perch, Mackerel, Herring, and Cod are the respective types. The species of the perch family are by far the most numerous of the Ctenoid fishes (comb-like scales); while those allied to the mackerel are equally predominant among the Cycloids.

“As an example of one of the fishes whose remains are extremely common in the Eocene, I give a restored figure of the *Sciænurus*. This genus is of the Ctenoid order, and not very widely removed from the perch.” — *Ansted's Picturesque Sketches of Creation*.



Sciænurus. Eocene Clay.

There was also a species of sturgeon existing during this period; also rays and saw-fishes, several species of shark, and others of a more monstrous character.

The *Reptiles* of the period inhabited the land, the

rivers, and the estuaries. They were lizards and crocodiles, turtles and tortoises. There were also serpents, not unlike the boa constrictor.

All of these animals indicate a tropical climate.

The remains of *Birds* are not numerous. Several species have been found in the London clay ; among them, a vulture, different somewhat from any existing species. From the Paris Basin, skeletons have been obtained which bear a close resemblance to the Pelican, Curlew, Owl, Buzzard, Woodcock, and Quail.

The *Mammals* are the most wonderful of all. The marl and gypsum beds in the neighborhood of Paris, known as the Paris Basin, are distinguished for being the cemetery of extinct quadrupeds. From this burying-ground originated comparative anatomy, under the genius of M. Cuvier ; and to this spot many an enthusiast in science has repaired, to see, to inquire, and to learn.

Several fossil land-plants are found in these beds ; also fresh-water fish, crocodiles, and fluviatile shells.

No pebbles or coarse sand occur in the gypsum ; hence it has been inferred that the sulphate of lime (gypsum) was deposited from water holding it in solution.

The following is an account of this remarkable Basin, given by Mr. Lyell :

“In this formation, the relics of about fifty species of quadrupeds have been found, all extinct, and nearly four-fifths of them belonging to a division of the order *Pachydermata*, which is now represented by only four living species: viz., three tapirs, and the damon of the Cape. With them a few carnivorous animals are associated, among which are a species of fox and jennet. Of the *Rodentia*, a dormouse and a squirrel; of the *Insectivora*, a bat; and of the *Marsupialia*, an opossum, have been discovered.

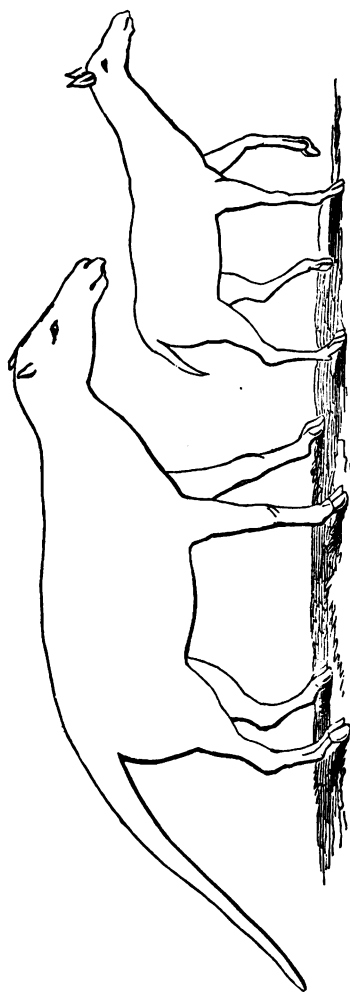
“Of birds, about ten species have been ascertained, the skeletons of some of which are entire. All of these are extinct. The same remark applies to the fish and to the reptiles.

“The tribe of land quadrupeds most abundant in this formation is such as now inhabits alluvial plains and marshes, and the banks of rivers and lakes—a class most exposed to suffer by river inundations.

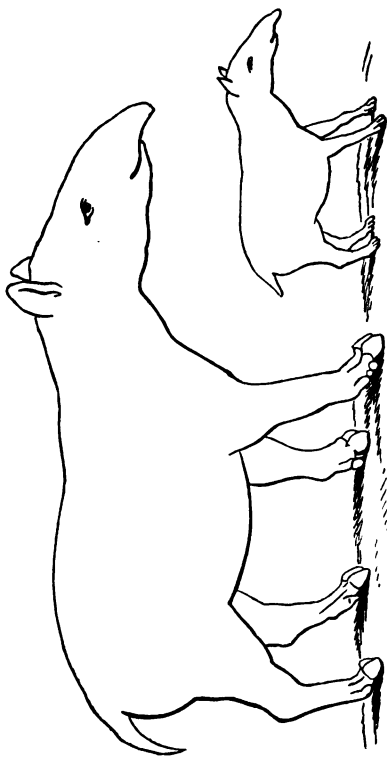
“The carnivorous animals were very few.”—*Lyell's Manual of Geology*.

Fossil Pachyderms have been found in the Isle of Wight, similar to those of the Paris Basin; and more recently, quite a number have been discovered in Nebraska.

In the white argillaceous limestone of the Eocene of Clarke county, Alabama, the gigantic bones of



Anoplotherium Commune. Anoplotherium Gracile.
From Mont Martre, near Paris.



Paleotherium Magnum.
From Mont Martre, near Paris.

Paleotherium Minus.

From Mont Martre, near Paris.

a cetacean, or whale-like mammal, have been found. Mr. Owen, the great comparative anatomist, has given it the name of *Zenglodon Cetoides*. The vertebral column of one skeleton, found by Dr. Buckley, measured nearly seventy feet.

Some thirty or forty individuals must have left their bones there; and all the evidence adduced by the ablest anatomists of America and England goes to show that they belonged to an extinct species of whale.

CHAPTER XVII.

Second or Middle Period of the Kainozoic Age—The Miocene Tertiary—Period of Extinct Mammals.

THE Miocene strata consist of sandstone, marls, and shelly limestone, enclosing beds of lignite; and, like the Eocene, they are both fresh-water and marine.

They are found in France, Switzerland, Germany, and Spain, and in the Southern States of our country.

The *Flora* has been mentioned.

The *Fauna* exhibits a variety of animals, from the lowest to the highest.

Among the *Radiates*, we notice the abundance of corals, constituting, in places, a rag or limestone deposit.

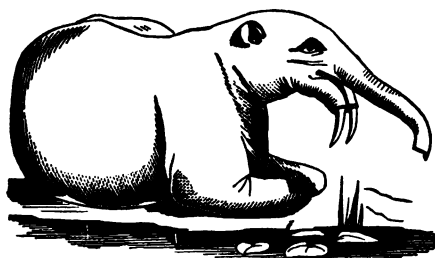
Among the *Molluscs*, we may mention the *Limnea* and *Planorbis*, fresh-water shells, and the *Cyprea*, *Oliva*, *Ancillaria*, *Mitra*, *Terebra*, and *Conus*, marine shells. Several hundred species of marine shells have been collected from the Miocene of the Loire,

in France, and some fifty or sixty species of coral. On the banks of James river, Virginia, Mr. Lyell collected about 150 species of Tertiary shells, thirteen of which he pronounced similar to Miocene species of Europe.

Vertebrates.—A great variety of sharks' teeth are found in the Miocene; many of them common to the Eocene, and a few peculiar to itself.

Turtles and fishes of various sizes have been found in the valley of the Rhine; and here the great Salamander was found which was mistaken for the skeleton of a man.

The most wonderful animal of this period was the *Dinotherium* (*deinos*, large; *therion*, beast); whose remains have been found in the valley of the Jura Mountains.



Dinotherium.

The following description of this animal is by Professor Ansted:

“It dwelt, probably, in swamps. Its length was nearly twenty feet; its body, huge and barrel-shaped, very much resembling that of the hippopotamus — being little raised above the ground, although the huge columns that formed its legs are supposed to have been nearly ten feet in length. Its head, rarely, perhaps, brought entirely above the water, was like that of a large elephant, and it was provided with a short, but very muscular and powerful proboscis. A pair of large and long tusks were appended to this skull, and curved downwards, as in the walrus. But observe the fact most remarkable of all:—these tusks do not proceed from the upper jaw, but are fixed in the lower jaw. They were probably useful as pickaxes, enabling the monster to dig for succulent vegetable food by day, while, perhaps, at night they could be attached like anchors to the banks of the river or lake in which the animal dwelt. It was the most gigantic of the herbivorous quadrupeds, and was associated with the Palæotheres of the more ancient Tertiary period, and with the mastodons and elephants which lived on till a far more recent date.”

Another remarkable animal of the Miocene is the *Sivatherium* — called from *Siva*, the Indian god. It was about the size of a rhinoceros. Its head re-

sembled the elephant's, and it had a short proboscis. Its striking characteristic was two pair of horns — one pair like an ox, over the eyes, the other branching and palmated, at the back of the head. It was a kind of link between the pachyderms and ruminants.

CHAPTER XVIII.

Third or Latest Period of the Kainozoic Age — Pliocene and Pleistocene Tertiary—Most of the Animals allied to existing Forms—The Glacial Era, or Boulder Formation — Drift — Loess of the Rhine — Quaternary Period, or pre-Adamite Alluvium, connecting with the existing state of things.

WE come, now, to the period where we find, in the very outset, a large majority of the fossil shells belonging to existing species; where a majority, if not all, of the species of mammals are extinct, but all the genera corresponding to existing genera; where icebergs floated in the Northern seas, and glaciers moved slowly and majestically from mountain slopes.

This period may be subdivided by different authors in a different manner. Indeed, some may make two or three distinct periods of the whole epoch; but the great facts remain the same.

The chronological order of this long period may be expressed in the following manner:

1. *The Pliocene era*, embracing a long lapse of time, and the rise and fall of many living creatures,

with elevations and depressions of land, as in all the eras preceding.

2. *The Pleistocene era*, including the Glacial era, or Boulder formation; also called *Drift*.

3. *The Quaternary period or era*, embracing the "closing up" of the Drift, the deposit of the Loess of the Rhine, the intermixture of extinct and living species, and the introduction of molluscous animals, all of which are identical in species with those now inhabiting our lands and waters.

The Pliocene era occupied the time of the deposits known as the Subapennine beds, or a larger part of them; and synchronous with these beds in Europe we may observe the sandy and marly strata overlying the Eocene deposits of North Carolina, Maryland, Virginia, and Delaware.

The characteristic *Molluscs* are the *Fusus Contrarius*, *Murex Alveolatus*, *Cypræa Coccinelloides*, and *Fusus Quadricostatus*.

The *Radiates* had two classes as representatives—*Polyps* and *Echinoderms*; the former by *Corals*, the latter by *Echinoids*.

The only *Vertebrates* found in the Pliocene are several species of fishes; none of which, however, we believe, have been detected in the United States.

They abound in the coralline crag of England.

**Fusus Contrarius.****Murex Alveolatus.****Nassa Granulata.****Cypræa Coccinelloides.****Fusus Quadricostatus, Say. Maryland.****Inferences :**

1. The Pliocene was wholly a marine deposit.
2. The extensive growth of coral and other marine animals indicates a deep sea.
3. The climate was temperate.
4. The history of the era is a death-blow to transmutation of species — not a quadruped, developed from previous quadrupeds, can be found.

The Pleistocene era links the Pleiocene with the Quaternary.

There is a remarkable contrast between this era and the one which immediately preceded it. We have just seen that the Pleiocene era recorded no land or fresh-water animals. They all had their home "in the boundless deep;" and, from all indications, they had a quiet time and a temperate climate.

Not so with the Pleistocene. It was, above all others, the era of prodigious land quadrupeds and others, in great variety, of moderate size—an era of land, fluviatile, and marine shells—an era when icebergs shook the bottom of the ocean—when a large portion of our North America was submerged, and thousands and millions of boulders were thawed out of their icy fastnesses, and sank down, to rise again with the reappearance of the immersed country.

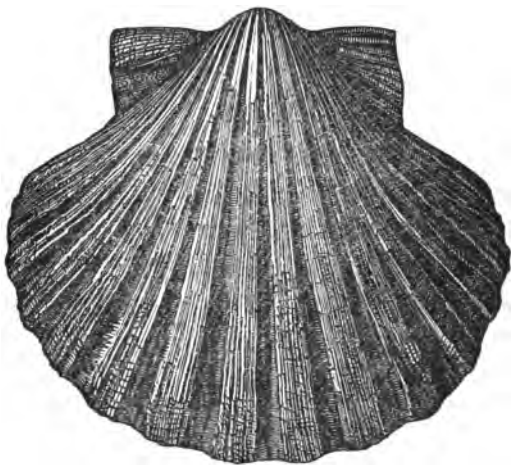
All the organic remains of this division indicate a near approach to existing races.

A buried forest underlying the *drift* on the coast of Norfolk, England, is described by Mr. Lyell, as belonging to this era.

The fluvio-marine crag of Norwich is considered by the same writer as a portion of the Pleistocene. This crag is composed of beds of sand, loam, and gravel, and presents to view a mixture of land,

fresh-water, and marine shells, and bones of mammals.

The island of Sicily is the most notable example of *Pleistocene strata* older than the Boulder formation. Here they attain the character of "regular-built" rock, and are quite different in mere lithological character from the low loose grounds in other parts of the world. The limestone rock is nearly as compact as marble, and its thickness amounts to nearly 800 feet. The shells contained in the limestone, being identical with the Pleistocene shells of other



Pecten jacobaeus; half natural size.

localities, enable the geologist to determine the age of the rock.

Fossils of the Pleistocene antecedent to the Drift. Radiates. — A coral reef is described by writers, situated on the island of Sicily. The corals are standing erect just as they grew. The bed is about two feet thick, and is composed of *Caryophyllia cœspitosa*.

Molluscs are very numerous. The *Pecten jacobæus* is a common fossil shell.

We find also the *Fusus striatus*, *Turitella terebra*, *Cardium edule*, *Tellina obliqua*, and *Natica helicoides*.

In other localities we may find large beds of oysters, similar to existing species.

The *Vertebrates* are the most distinguished animals of the era.

The valley of the Thames, the crag of Norwich, and other places in Europe, as well as various localities in the United States, exhibit the remains of huge quadrupeds which are now totally extinct. We notice the *Megatherium*, which ranged from Patagonia in South America, to corresponding latitudes in the United States.

It belonged to the *Edentata*. Length, 18 feet. Breadth across the loins, 6 feet. Height, 9 feet. The fore-legs resemble those of the sloth. Fore-foot, 3 feet long. The fore-legs were well adapted

for seizing the trunks of trees, and, doubtless, there was strength enough in the animal to pull one down with very little trouble. Its grinders were sufficiently powerful to eat the roots.



Skeleton of the *Megatherium*.

The *Mylodon* was cotemporary with the *Megatherium*. So was the *Megolomys*—and the *Elephas Primigenius*, two species of extinct *Rhinoceros*, etc.

The length of the *Mylodon* was eleven feet.

It was a vegetable-eating animal, and obtained its food directly from the trees, the leaves and buds.

It was likewise a sloth-like animal.

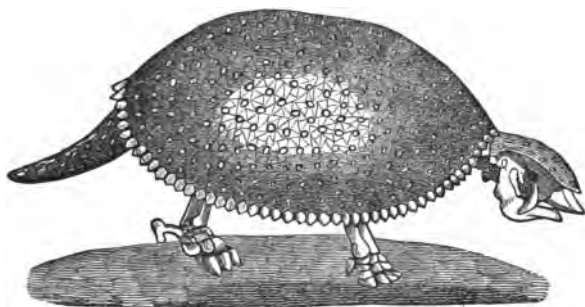


Mylodon Robustus.

The *Glyptodon* was a magnificent armadillo, and its habits were, doubtless, quite similar to the living animal it resembles.

We enter next upon the record the genus *Mastodon*, of which there are several species.

It is worthy of notice, that this race of quadrupeds commenced existence during the Pleistocene and continued to exist until, probably, the close of the Quarternary era. Some of them were caught by

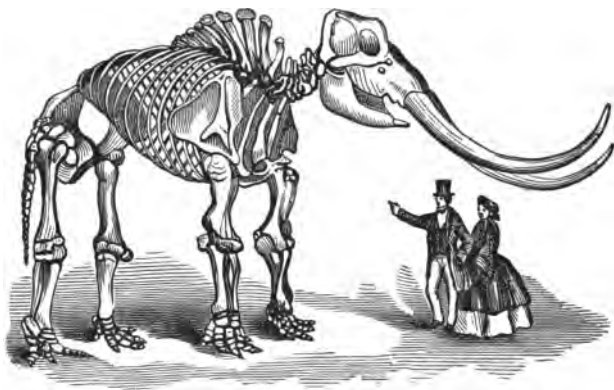


Glyptodon Clavipes.

the *Drift*, but others pursued their herbivorous habits in a region out of the reach of the Drift, from the latitude of Delaware Bay in North America, to the mouth of the La Plata in South America.

We find their remains in deposits before the Drift, during the Drift, and after the Drift. They were wanderers, up and down, upon the face of the earth; and if their bones could speak—if those fossil “lips had language,” what a tale would they unfold—of the rise and fall of many generations—the graves of their ancestors—the sepulchres of their cotemporaries—of the migration of a part of their great family when the ocean of the North crept stealthily upon their territory—of the close of that era and the return of the land to its original level—of the tall cypresses which afforded them sustenance—of the change of climate, after the great

Arctic Sea with its floating islands of ice invaded our continent, and the return of a more genial climate when the upheaved land took a position which it has maintained, with slight oscillations, to the present day.



Mastodon found in Newburg, N. Y.

The Mastodon had a companion, and, (speaking after the manner of men,) a distant connection in the *Elephas Primigenius*, often styled the Mammoth.

The remains of this animal have been found in the Western Hemisphere from 33° North latitude, to the Polar regions, and, in the Eastern Hemisphere, from the south of Europe to Siberia.

Cotemporary with the mastodon and extinct elephant, were hyenas, cavern bears, rhinoceroses, hip-

popotami, horses, hogs, bears, and other animals. The species of nearly all these animals are lost. The genera still live.

Osseous Caverns.—Caverns are found in various parts of Europe, containing the bones of the animals we have just mentioned.

The celebrated cave of Kirkdale may be mentioned as a model. In this cave Dr. Buckland found the remains of 300 hyenas and various skeletons of the ox, elephant, hippopotomus, horse, bear, etc., as well as rats and birds. The bones have the appearance of being gnawed and broken; and it appears that it was a den of hyenas, who dragged their prey within, and devoured it. Thirty-seven species of mammals have been described by Professor Owen, belonging to the caves of Great Britain, eighteen of which are extinct.

The Drift.—We mean by the *Drift* the great boulder and gravel deposit found all over the northern part of the United States—all over British America, and corresponding portions of the Eastern Hemisphere.

It is rarely found in our country south of the parallel of 40°.

The period of the *Drift*, or the Glacial epoch, is the time which was occupied in the moving and

depositing of these boulders and the accompanying gravel and sand.

The deposit has been called Diluvium, and the period, the Diluvial period; but, for reasons already given, we consider the name Drift the most satisfactory title that can be given.

The reader will remember that the whole phenomena of drift—the erratic blocks or boulders, lying on the surface, the sand and gravel lying under the surface-soil—all indicating a rolling and grinding movement,—and the large scratches found upon mountains, as well as in valleys, have been attributed to the agency of icebergs and glaciers. He must also bear in mind that, in order to account satisfactorily for the position of these erratics, we must adopt the theory of subsidence and upheaval.

In other words, we must conceive that, after the continent of North America had assumed a shape and condition nearly, if not altogether, like the present contour, there was a gradual submerging of the larger part of the land, and a subsequent upheaving. During the subsidence, islands of ice enclosing boulders of granite and granitoid rocks floated down from northern regions, and ground and furrowed the rocks of the submerged hills and valleys, and then scattering themselves far and wide, borne about by currents and melted by the rays of

the sun, they left these rocky masses and pebbles at the bottom of the then existing Northern Sea. Long after these droppings of the icebergs, the land was elevated, and all over our northern States and Canada we have what is familiarly styled the Drift.

This Drift has its fossils. There are none, it is true, in the solid granite blocks; but in the gravel and loam, which constitute a part of the drift, we find shelly beds at various heights above the level of the sea, from 200 to 400 feet, containing the remains of *Mya truncata*, *Saxicava rugosa*, and other marine shells, together with *Mytilus edulis* (common mussel,) and other fluviatile shells.

The *Mastodon giganteus* is also found in the clay and gravel of the Drift, as well as later deposits.

The climate of the Glacial or Drift period was doubtless very cold, but it must be borne in mind that this climate did not embrace the tropical regions. Icebergs are now floating from the Arctic and Antarctic Oceans—melting and making their deposits by thousands, and yet we have a comfortable and warm climate in our temperate and intertropical regions.

Why may not the same have occurred during the epoch of which we speak?

The same remark may be made in reference to

glaciers. Although, during that long era, the cold was more widely diffused, still there were regions, such as our "Sunny South," and the West Indies and Brazil, with other portions of South America, where land animals and denizens of the ocean had pleasant places of abode.

The Arctic region was the great "starting-place" for the erratic rocks; but we must mention that the summits of Mont Blanc and Monte Rosa were also sources whence large and small masses have found their way down into the near regions of France, Austria, and Switzerland. The modern glaciers of the Alpine region may be regarded as models of the ante-historical glaciers.

The Quaternary Era, as we have before stated, is the connecting link between the Pleistocene and the Human or Androzoic age.

During this era the molluscos animals all belonged to species which are still existing. The mammals were partly of species which we still find. Some of them have become extinct. No vestige of a human skeleton can be found, except such as may have been washed in some loose beds of marl out of graves, or from a battle-ground.

It embraces the latter part of the Drift, includes the Loess of the Rhine, together with all the volcanic tuff formed contemporarily with the latter deposit.

It has been designated post-Pliocene, but as this name may mean any deposit or any era *after* the Pliocene, and may, according to the import of the term, mean the human epoch, we prefer the term Quaternary.

The period of which we now speak, is represented in its mineralogical aspect by the bluff banks of the Mississippi occurring at *Memphis, Vicksburg, Natchez, and Fort Adams*.

The *Fossils* found in these marl bluffs embrace land and fresh-water shells and mammals.

The shells are all of recent species, and embrace some forms of *Helix*, *Pupa*, *Bulimus* (land), and *Lymnea*, *Paludina*, *Planorbis*, and *Succinea*, (river).

We have gathered a number of these from the points named on the Mississippi river, and at different localities for fifteen and twenty miles from the river. The formation never extends far into the interior.

Bones of *Elephas Primogenius*, *Rhinoceros ticherinus*, *Ursus spelæus*, *Hycæna spelæa*, *Equus caballus*, etc., etc., have been found in the Loess of Germany; but we have found no vertebrated animals at all in the American deposit.

The imbedding of common snail shells, together with fresh-water shells, in a bluff, fifteen, twenty, and thirty feet from the surface, suggests an inquiry

to the mind which ought to find an answer from scientific research.

How did these perfectly formed shells find their way into these bluffs?

The only satisfactory answer which geology can give is the following:

Subsequently to the latest Tertiary period, the land underwent subsidence; and after several hundred feet of clay, gravel, etc., were deposited, the region was slowly upheaved.

For an elaborate discussion of this view, the reader is referred to Mr. Lyell's "Principles of Geology."

CHAPTER XIX.

The Androzoic Age—Man and his Animal Associates—The Vegetable kingdom — Plants suited to his Wants — His Organization declares him a superior Being — Fossil Human Remains.

WE have arrived, at length, in our survey of the living ages of the globe, at the great epoch when God said, "Let us make man." A new order of things is about to commence—a new state of society, based not upon instinct and animal impulse, but upon *mind*, and its capacity to draw near to the throne of the universe, and hold communion with its Maker. We notice briefly the following facts :

1. In the creation of man we have a type of creative power. It was a distinct, individual, miraculous display of Divine power, which philosophy cannot explain. So the creation of every species that preceded man was a separate and peculiar exhibition of omnipotence. Furthermore, as God formed man of the earth, and breathed into his nostrils the breath of *lives*, so that he became an *animal* and a SPIRITUAL being, so did he form pre-existing species

out of the earth, breathed into them the breath of *life*, and they became *animal* beings.

2. All the animals created with man were designed to perform co-ordinate functions—co-operative offices; the entire combination of labor having reference to the welfare of the human family.

It is said that Dr. Franklin once asked, “What is the use of a new-born babe?” And we have often been asked, “What is the use of a candle-fly, or a humming-beetle, or a grub-worm?”

We invariably answer our young friends thus:—God has made them—he has made them for some purpose. We see the utility of the horse, the cow, the camel, the hog, the birds, the fish, etc., as beasts of burden, and as food. There are also many carnivorous animals, which have been made for the purpose of taking life, to prevent exuberance. There are myriads of insects designed as food for birds, and these birds are directly or remotely useful to man. Suppose, now, after studying this admirable display of co-operation and dependence, we should notice some fact which we could not readily explain. Is it the part of wisdom to doubt? No. Let us say, “there is a Providence that shapes their ends.” There is a “God over all”—man, beast, bird, reptile, and insect. The inexplicable bug fills his place. To believe this is the dictate of sound

philosophy, and, at the same time, the function of *Faith* — the humble offering of the creature to the Creator.

3. The same grand principle is applicable to the vegetable kingdom. All the plants, trees, shrubs, flowers, grasses, and weeds of the human epoch, contribute in various ways, seen and unseen, to the promotion of the great end — the *Dignity and Dominion of Man*.

Not only has he the fruit-tree, yielding fruit, and the flower upon the shrub—the one for food and the other for beauty; not only may he gather fuel to warm his body, and “corn, and wine, and oil,” to contribute to his animal wants; but out upon ten thousand hills and plains he finds the *Exogenous timber*—just such timber as is needed to make his houses, and his ships, and his implements of industry, in order that he may advance from the animal standpoint, and obey the command, “Take dominion, and subdue the earth.”

4. We remark, in the next place, that none of these physical conditions existed in the ages prior to man. Man could not have lived in the Silurian and Devonian times of the earth; for he could not have found soil enough on dry land to raise a hill of corn. Nor could he have lived in the Carboniferous era; because all the terrestrial and atmo-

spheric conditions were entirely unfavorable for an air-breathing animal.

Neither could he have flourished to advantage in any of the Secondary or Tertiary periods; because he could find no use for any of the Saurians or Pachyderms of those ages; the *Endogenous* growth could not supply all his wants for food or for industrial material, and for mosses, ferns, and lycopodiums, in their living state, he would have no use whatever.

5. The external form and features of the globe in its present state, the shape of continents, the distribution of land and water, the course of rivers, the currents of the ocean, the currents of the atmosphere, and the variations of climate—in a word, all the developments of physical geography—exhibit the earth as a suitable dwelling-place for man.

“We shall see,” says Professor Guyot, “all the great phenomena of the physical and individual life of the continents, and their functions in the great whole, flowing from the forms and the relative situation of the great terrestrial masses, placed under the influences of the general forces of nature.

“But we must elevate ourselves to the moral world, to understand the physical world; the physical world has no meaning except by and for the moral world. Every being exists not only for itself,

but forms necessarily a portion of a great whole, of which the plan and the idea go infinitely beyond it, and in which it is destined to play a part. Inorganic nature is made for organized nature, and the whole globe for man, as both are made for God, the origin and end of all things.

“Considered in this point of view, the earth, and all it contains, the continents in particular, with the whole of their organized nature, all the forms they present, acquire a new meaning and a new aspect.

“It is as the abode of man, and the theatre for the action of human societies, it is as the means of the education of entire humanity, that we shall have to consider them, to appreciate the value of each of the physical characters which distinguish them.

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“While all the types of animals and of plants go on decreasing in perfection from the equatorial to the polar regions, in proportion to the temperatures, man presents to our view his purest, his most perfect type, at the very centre of the temperate continents, at the centre of Asia-Europe, in the regions of Iran, of Armenia, and of the Caucasus; and departing from this geographical centre in the three grand directions of the lands (Eastern Asia, Africa, and America), the types gradually lose the beauty of their forms in proportion to their distance, even to

the extreme points of the southern continents, where we find the most deformed and degenerate races, and the lowest in the scale of humanity. The continents of the north are inhabited by the finest races; the continents of the south are exclusively occupied by the inferior races. These differences are not of yesterday or to-day. The annals of the southern tribes never record the birth or progress of a single civilization.

“The distribution of man over the surface of the globe, and that of the other organized beings, are not founded on the same principle. The degree of perfection in animals and plants is proportional to the intensity of heat and other agents; the law is physical. In man, the degree of perfection of the types is in proportion to the degree of intellectual and moral improvement. The law is moral.” — *Earth and Man*.

6. Man is the most independent animal on the globe. Inferior animals have their provinces, and plants their latitudes, but man has all provinces and all latitudes. He may not be born in the immediate vicinity of the open Polar Sea, but give him the “men and the means,” and he will go there in spite of all remonstrance.

7. The human skeleton displays physical perfection superior to any organization on earth. The

most degraded Hottentot can *walk erect*, and perform evolutions with hands and feet which the Chimpanzee cannot execute.

The Hottentot is a *man* — not an improved monkey. He is the monkey's master.

8. Notwithstanding the physical and moral degradation of the African and South American races, man, everywhere, is found subduing the earth and taking authority over the most powerful of the inferior animals; he is found upon land and water, fishing and hunting, and planting and *improving* upon his previous labor.

The being to whom authority has been given over air, water, and land, (all three,) is man. (Gen. i. 28.)

No animal that preceded him ever received such authority; they all have their courses and their limitations. Man is sole monarch by Divine appointment.

9. The fossil remains of man are found in the historical deposits — modern alluvium and coralline limestone—also in caves where they have drifted, or have been conveyed by beasts, such as hyenas—likewise in any of the openings—trenches and ravines—of the Tertiary or post-Tertiary clays and gravels and sands, where they may have been thrown or dragged. These trenches and deep ravines subsequently filling up, and forming, in the course of

centuries, a tolerably compact mass of earth, might make an exhibition calculated to deceive. The Gaudaloupe skeletons are well-marked specimens of fossil human bones. They were found in a recently formed limestone on the shore of Gaudaloupe, and they are preserved in the museums of Charleston, London, and Paris. Stone hatchets, arrows, and pottery, were found with them. Petrifaction had not taken place. The rock in which they were found is still forming. It is partly a coral crag.

The Mineral accumulations of the Androzoic age consist:—1. Of the historical portion of alluvial plains and deltas. We have shown that a portion of these plains and deltas must have been formed previous to the human epoch.

2. *Raised beaches*, some of which have been brought up slowly, and others by volcanic action, as on the coast of Chili.

3. *Corallo-argillaceous limestone*, such as that in which the human bones are found on the coast of Gaudaloupe.

4. *Travertin*: a light porous limestone deposited on the banks of streams and bottoms, investing shells, sticks, bones, and limestone and sandstone rocks—found also about warm springs.

5. *Shell Marl and Clay Marl*, found in lakes, ponds, and swamps.

6. *Coral Reefs*, a description of which we have already given.

7. *Volcanic Lava*.

There is some misapprehension in reference to the word *Alluvium*. Derived from *alluo*, to wash, it means a deposit of gravel, sand, and mud, with or without vegetable or animal matter. The term has been appropriated by some writers to designate solely and exclusively the "recent and progressive formations," such as river-bottoms which we now see forming. By others it is used in a more extended sense, and embraces pre-Adamite deposits. It will require a convention of geologists to settle the question. So far as the etymology of the word is concerned, either may be right; but one thing is certain — a larger part of the great alluvial deposits of the great rivers of the earth is *ante-historical*, or geological theory is false.

We certainly have ancient alluvium and modern alluvium—more than that, we have alluvial beds—very ancient ones—lying in snugly between the strata of ancient rocks. In a word, we have alluvial deposits of all ages.

The popular sense of the word is, modern sediment, but the facts just stated cannot be overlooked.

Fossil Vegetables of the present time.

The silt of river-bottoms contains immense quan-

tities of vegetable matter—such as leaves, sticks, logs, nuts, etc. etc., some of which have undergone partial bituminization. We have found such deposits all along our great Father of Waters, at different distances from the surface, from 3 to 10 feet. Similar deposits have been found all over the world.

Peat mosses must be regarded as fossil vegetable matter. The old black peat found low down in the earth is a formation antedating the present, or human era—but the peat mosses found in or near the surface belong to our times, that is, they have been generated since man was created.

A portion of the silicified wood of our Southern States belongs to the historical period. There are doubtless many localities where silicification takes place rapidly; and there can be no question that fragments of modern trees have undergone the change in the course of a single century. We have a few specimens of silicified oak, which we think cannot be longer than five hundred years from the acorn.

Remains of quadrupeds, such as the horse, ox, hog, bison, buffalo, etc., as well as shells, have been found in river terraces and in swamps.

These remains are also found in *Licks*, in connection with the bones of extinct quadrupeds, such as the mastodon and ancient elephant, etc. These

licks appear to have been places of resort for animals of different ages, to obtain salt.

Before man existed, the mastodon "bogged down" in the licks and was buried. After man was created, the buffalo came and tried the place with a like result—and thus the lick became a cemetery. Each animal left his obituary notice, and the whole makes a record of different epochs.

We have unquestionable evidence of the extinction of one animal during the age of man. That animal is the *Dodo*, a bird of the gallinaceous tribe, somewhat larger than a turkey. Two centuries ago it was living in Mauritius and the adjacent islands. Not a living Dodo can now be found. Its bones may be seen in British museums, and they have been found in a fossil state in the tufa of the Isle of France.

It is an open question, whether any other animal cotemporary with man, has ever become extinct.

PART III.
MORAL BEARINGS OF GEOLOGY.

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CHAPTER XX.

The Antiquity of the Globe.

How old is the globe? Popular opinion answers, About 6000 years. Geology answers, Myriads of years. Popular opinion is sustained by time-honored ecclesiastical authority: Geology is sustained by more ancient authority—the enduring records of the earth.

No Christian, who understands the science of Geology, has any doubts on this subject, or any misgivings as to the verity of the sacred history. Doubts and difficulties arise in the minds of those who have not informed themselves on the principles of the science.

I remember distinctly, when Lyell's *Principles* first appeared west of the Alleghanies, some twenty-five years ago, the work was denounced as an impudent attack of a heartless infidel upon the authority of the Bible, and I was advised by good friends not to read it. For some years I followed the advice. At length curiosity, stimulated by taste, induced me

to examine it, and the result of my examination is simply this. It is one of the few, very few original scientific works of the 19th century, and it justly entitles its author to take rank with Humboldt, and Franklin, and Newton. And, so far from "poisoning my mind," it has strengthened my faith and enlarged my veneration, though I do not fully agree with the author in his ideas of uniformity. No difficulty exists in the minds of any of the great Christian geologists of the present age, in reconciling the facts of geology with the first verse of Genesis.

I will present a few short, elegant extracts from the best authors on this point, and let the reader judge for himself.

1. "Millions of millions of years may have occupied the indefinite interval between the beginning in which God created the heaven and the earth, and the evening or commencement of the first day of the Mosaic narrative. This opinion is in perfect harmony with the discoveries of Geology."—*Buckland*.

2. "Long,—very long ago—many ages before the creation of man, this world, on which we dwell, existed as the habitation of living beings. . . . It is a history of antiquity, *clearly made out by a chain of evidence*, different indeed in kind from that ordi-

narily resorted to for the establishment of historical views, *but not for that reason less satisfactory or convincing.*"—*Ansted, Prof. Geology, King's College, London.*

3. "What years must have gone by since that ocean flowed which has left its ripple marks on the sand, now a solid mass on the mountain—since those unknown creatures left their footprints on the shore, now fixed by time on the rock forever!—time which man measures by days and years, nature measures by *thousands of centuries.* The earth proclaims God's handiwork."—*Mary Somerville.*

"In Mrs. Somerville's pages no sentiments are recorded which the Christian or philosopher disowns."—*North British Review.*

4. "Let us conceive, if we can, that the atoms of one of these strata have formed the sands of an hour-glass, and that each grain counted a moment, and we may then make some approximation to the past periods of geology; periods in the computation of which the largest human dynasty, and even the data of the pyramids, could form only an insignificant fraction.

"Can we think of the thousands, not of the generations, but of species which have all run through their ages of existence and ceased, without feeling that we are standing on ground so immeasurably

far back in the night of time as to fill the mind with awe? . . . And that thought—what direction more natural for it to take than to plunge still further back into the dark abyss of departed time, till it has reached a first or efficient cause?

“My *firm persuasion* is, that the first verse of Genesis was designed by the Divine Spirit to announce the absolute organization of the material universe by the Almighty Creator, that passing by an indefinite interval, the second verse describes the state of our planet immediately prior to the Adamic creation, and that the third verse begins the account of the six days’ work. . . . I am simply making the works of God illustrate his word in a department in which they speak *with a distinct and authoritative voice*.”—*Dr. Harris, Pre-Adamite Earth.*

5. “I am forming no hypotheses in geology. I only plead that the *ground is clear*, and that the dictates of the Scripture interpose no bar to observation and reasoning upon the mineralogical condition of the earth and the remains of organized creatures which its strata disclose. If these investigations should lead us to attribute to the earth and to the other planets and astral spheres an antiquity which *millions or ten thousand millions of years* might fail to represent, *the Divine records forbid not their deduction*.”—*J. Pye Smith, Script. and Geol.*

6. "I trust that all who hear me are satisfied that the Mosaic history of the creation of the world does *fairly admit* of an interpretation which leaves an undefined interval between the creation of matter and the six days' work. This is a case in which we may call in the aid of science to ascertain the true meaning of Scripture. The question is, Does geology teach distinctly and incontrovertibly that the world must have existed during a long period prior to the existence of the races of organized beings that now occupy its surface?"—*Dr. Hitchcock*.

The Doctor goes on to defend the affirmative of this question, and among other things, speaks of the Delta of the Mississippi river being nearly 15,000 years old.

Such is the testimony of a few witnesses—just a few specimens. We could adduce four or five times as many from our limited resources, but space will not permit.

Indeed, we have a sacramental host of infidels from Chalmers and Buckland, down to Hitchcock and Pye Smith. Some forty or fifty, and these all are *one*. They agree with Lyell on the age of Niagara, and with one another upon the high antiquity of the earth. Ay, more. No Christian geologist, in the year 1860, would rise in a geological society and endeavor to defend that interpretation of Gene-

sis which assigns to our globe an antiquity reaching back only 6000 years, without running the risk of being made an object of merriment.

We purpose now to adduce, in order, the arguments on this subject, which we deem conclusive; and all we ask of the sceptical reader, is a candid examination of the whole series, with a request that he will constantly bear in mind that no argument from the opposite side, drawn from miraculous Omnipotence, can be deemed tenable, unless it be shown from reasonable revelation that such Omnipotence was actually displayed.

We propose the following arrangement of our arguments:

1. From the monuments of antiquity.
2. From the deltas of rivers, and their alluvial plains.
3. From the absence of human remains in any strata of compact rock under the superficial.
4. From the absence of remains of inferior animals cotemporary with man in all the deposits under the superficial.
5. From a stratigraphical view of the aqueous rocks.
6. From river gorges.
7. From volcanic action.
8. From mountain upheavals.

9. From buried forests.

10. From a philosophical view of fossil remains.

Argument 1st.—The Monuments of Antiquity afford Negative Evidence that the Earth is older than 6000 years.

The drawings exhibited in the works of Lepsius, Champollion, Rossellini, and others, present to our view the figures of a great number of animals represented on the monuments of Egypt. These monuments date back nearly 4200 years ago, to a period cotemporary with the flood. On these monuments may be seen delineations of hundreds of animals and plants. The animals are the ox, crocodile, camel, antelope, jackal, hedge-hog, goose, duck, various fowls, donkey, bull, goat, monkey, hyena, porcupine, wolf, fox, ostrich, ibis, etc., etc.

In like manner, Botta and Layard have shown us Assyrian monuments which portray a great many animals. But on none of these tablets, Egyptian or Assyrian, do we find a single figure indicative of the existence of an animal marked by the geologist as a pre-Adamite. These ancient people, it appears, were in the habit of cutting, carving, or marking, in some style, every living object, animal or vegetable, every production of art, every form of human face, and every shape of living creature, for the purpose of leaving to posterity memorials of their existence. How does it happen that we find no

sketch of any of those magnificent quadrupeds and reptiles which once flourished on the earth?

What a magnificent deity the *Megalosauros* would have made! A combination of crocodile and monitor, sixty feet long, of most imposing form and action, he was just "the very thing" for an idolater to bow down to and worship.

Then we must not omit to mention the tremendous *Dinotherium*, the bulky *Megatherium*, and the more graceful *Anoplotherium*. Why do we not find them figured on ancient monuments? The anti-geologist will answer, They were extinguished by the flood. Was the memory of them totally extinguished? The Ninevites and Egyptians worshipped forms and figures; might they not have preserved the form of any of these splendid beasts?

But setting this aside, let us notice the remarkable fact that the flood did not extinguish the sea animals. If, then, the great Saurians flourished from Adam to Noah, it is highly probable they survived the flood — at least, it is nowhere stated that marine animals perished. Again, we ask how happens it that we have no monumental history of any of these crocodiloid animals? Not the least scratch of an instrument upon any movable or immovable object indicates an existence of huge Saurians contemporary with man.

The truth is, they lived, died, and were buried, long, long before man had his existence. Their own remains are the monuments of an antiquity antedating anything that man has made.

Argument 2d.—The Deltas of Rivers, and their alluvial Plains, exhibit a lapse of Time which reaches back many Centuries prior to the Adamic Genesis. Delta of the Nile, and the Alluvial Deposit up the River.

“Egypt is the gift of the Nile.” So we read in our Latin book, when we attended the recitation of our professor, years ago. We never understood it until we studied geology.

According to the best accounts, “the sea once washed the base of the rocks on which the pyramids of Egypt now stand. That base is now washed by the Nile.” “The land about Elephantine,” says Sir J. G. Wilkinson, “has been raised nine feet in 1700 years; at Thebes about seven feet; and at Cairo about five feet ten inches.” At Rosetta it is still less.

At Cairo, the mud is stratified in such a way that one may detect the annual layers.

It has been calculated that a stratum of two or three feet will represent the accumulation of 1000 years. It is plain to see that the entire accumulation of many feet will represent many times 1000 years.

Delta of the Ganges.—The portion annually inundated makes an area of 20,000 square miles. “The space south of this in the bay, where sediment is thrown down, embraces about 45,000 square miles; giving altogether a surface of 65,000 square miles, over which the sediment is spread out by the two rivers (the Ganges and Brahmapootra). The solid matter, by calculation, deposited, amounts to 40,000 millions of cubic feet per annum. The deposit must continue forty-five years and three-tenths, to raise the whole area a height of one foot; or 13,600 years, to raise it 300 feet; and this is much less than the thickness of the fluviatile strata penetrated by the auger at Calcutta (and the bottom not reached).” —*Lyell's Principles*, p. 284.

Delta and Alluvial Plain of the Mississippi.—Borings near Lake Pontchartrain, north of New Orleans, have reached a depth of 600 feet, and the bottom of the alluvial matter is not yet touched.

“The area of the delta is 13,600 square miles. The quantity of solid matter annually brought down by the river is 3,702,758,400 cubic feet; hence it must have taken 67,000 years for the formation of the whole; and if the alluvial matter of the plain above be 264 feet deep, or half that of the delta, it must have required 33,500 more years for its accumulation, even if its area be estimated as only equal

to that of the delta; whereas it is, in fact, larger."—*Ibid.*

After making proper allowance, then, it appears that the Mississippi river has been running for about 100,000 years. Still further, it appears that the Mississippi has cut its way through still older formations; and that the immense alluvial deposit at its terminus is a young one, in comparison with the grey old rocks about its source. But of these we shall speak in the proper place.

Before proceeding to our next argument, it will be proper to notice that an exact *unit* of measure is not demanded in making these calculations. In different localities, and under some variation of circumstances, sediment may be deposited one year more slowly or more rapidly than another. We undertake to express a fair average.

Argument 3d. — The absence of Human Remains in any strata of compact Rock under the superficial Sands, and Gravel, and Clay, etc., supports the Doctrine of the high Antiquity of the earth, as taught by Geologists.

Man is found in a fossil state only in the most recent deposits—those which have occurred since his creation, or those of a loose and superficial character, which may have been deposited before his creation.

Let us notice a few cases.

1. *The Guadeloupe Skeletons.*—A number of skeletons of men have been discovered in the West Indies, on the north-west coast of Guadeloupe, *in a coralline shell limestone, which is forming every day.* Both the coral and the shells are of living species, and the skeletons retain their animal matter, and all their phosphate of lime.

They are not petrified. The rock in which some of these skeletons are found is as hard as marble. It is described by eye-witnesses as an “indurated beach, which slants from the steep cliffs of the island to the sea, and is nearly all submerged at high tide.”

2. *Human Remains in Caves.*—It is plain that caverns may remain open from one geological age to another, and that the remains of animals of different ages may become commingled. Hence cavernous fossils are not very reliable chronometers.

Human skeletons have been found in the caves of Europe and America, enclosed in clay and united by stalagmite.

The remains of extinct animals become mixed with recent bones and shells. On the banks of the Mense, human bones have been found in caverns with the bones of the extinct elephant, rhinoceros, and bear. They seem to have been washed in by a current.

In the south of France, human bones and pottery are found in a cavern of Tertiary limestone. They are not imbedded in the limestone, like the Gaudaloupe skeletons, but mixed up with bones of hyena, rhinoceros, and bear, and imbedded in alluvial mud as solid as travertine.

It requires a long time for bones to petrify. French chemists have examined human bones taken from a Gallic sarcophagus which had been resting for sixteen centuries. They were rather more solid than fresh bones, and had lost three-fourths of their animal matter.

Human bones found in caves associated with pottery, flint hatchets, and arrow-heads, must belong to the period of the mound building. In point of time, they rank with the skeletons of ancient American mounds; the difference being simply this: the skeletons of the caverns have been buried by natural causes, and are, therefore, human fossils; the skeletons of our mounds have been buried by the hands of man, and are, therefore, not fossils.

Pseudo-Human Fossils. 1. *Footprints in Missouri.* — Some years ago, a great noise was made about a couple of elegant-looking human footprints upon a sandstone or limestone in Missouri — a large, solid rock, of the Carboniferous era, I think; at least a very ancient rock, according to geology.

It made the people stare, and struck terror into the hearts of some geologists who were not initiated into the knowledge of the Indian character.

Editors asked questions, and called upon American savans to solve the mystery. Anti-geologists laughed, and declared geology was a humbug; while nobody seemed to think it worth while to ask, *How does it happen that there are just two footprints, and no more? If they were made by a man standing up, where did the man go to?*

It was not long, however, before the real origin of the feet was found. The Indians had cut them a century or two ago.

I have seen similar etchings on stone in East Tennessee. The hard encrinital limestone is marked with tracks of turkeys, etc.

Dr. Ramsey, the learned historian of this State, who resides near Knoxville, showed me some of these Indian lithographs.

2. *Fossil Woman in Mississippi.* — Nine years ago, a friend met me on the street in Jackson, Mississippi, and opening a paper, exclaimed, "Now, sir, you'll have to give it up."

"Give what up?" said I, in great haste.

"Why, sir, all your geology — at least, all your speculations. Here is an account of a fossil woman — a real *petrified skeleton of a woman.*"

I took the paper, read it over very carefully, and noted especially that the "petrified skeleton" weighed *several hundred pounds*.

While I was reading, a number of gentlemen came around me, and they were all anxious to know how I could explain the matter. The significant grin of fun was on the countenance of every looker-on; and it was shrewdly suggested by a waggish gentleman that I would get out of the difficulty by stating that I had declared *no petrified MAN* could be found; and as this was a petrified *woman*, I was not bound to give any explanation.

"The matter is very easily explained, gentlemen," said I. "Neither a petrified man nor a petrified woman has ever been found. The paper is mistaken; and if you would remember a little chemistry which you have learned, and just go read any small treatise on elementary geology, you wouldn't want me to explain; you could understand it yourselves, and you would not allow yourselves to be hoaxed. However, as you have asked me to explain, I will do it.

"You may have noticed on the banks of some streams, that the sticks, and leaves, and little shells called periwinkles, are all covered over or incrustated with lime."

"Oh yes; often, often," said several voices.

“Well, now, this incrustation is nothing more or less than the carbonate of lime, deposited from the water. I have noticed it in East Tennessee and in Kentucky; and you will find it in the Sweet Springs of Virginia, the Hot Springs in Arkansas, and at the Falls of Niagara. Now the same phenomenon often occurs in graves. The limestone water, percolating the sides, finds its way to the skeleton, and forces a way out, so as to make a sort of stream running through the grave. The carbonate of lime deposits itself round the bones, and in this way the limbs enlarge, and the whole mass weighs several hundred pounds. My word for it, gentlemen, this is not a fossil woman, but a woman’s skeleton encased in *travertin*.”

The company dispersed, apparently satisfied; and in a few weeks it was ascertained that my explanation was correct. It was a case of *sepulchral incrustation*.

3. The *Homo Diluvii Testis* of Scheuchzer, after exciting the wonder of European savans, was ascertained by Cuvier to be a big salamander.

But the greatest wonder, and the most enlarged humanity, in the way of “*petrification*” (?) that ever attracted the gaze of modern wonder-seekers, was exhibited in our Southern country some twelve years ago. I must call it

4. *Homo Tennesseeensis*. — Milton's fiend was nothing to compare with it. It surpassed all the giants of Scripture, and filled up the measure of Hercules multiplied by seven. The comments upon his character by country gentlemen whose risibles had been excited by the *tickler* were highly entertaining; and the surprising tale of his discovery in a certain county of Middle Tennessee made the boys open their jaws very wide, and hold them open to a painful extent of time.

It stood about twelve feet high; having attained, in its skeleton form, seven feet over the position it occupied when clothed with flesh and skin. Having lost its head (as the worthy proprietor supposed, in Noah's flood), one was given to it, ingeniously constructed of a sheep-skin, fitted over a frame-work of a cranium—the first of the kind ever formed by the skill of man. It was with marked propriety, therefore, that one of the aforesaid country gentlemen, under the influence of the tickler, marched up to this mammoth man, and exclaimed, "Look here, *old Mutton-Head*, tell us, where *did* you come from?"

This miracle of a fossil man was exhibited in Nashville, Memphis, Vicksburg, Natchez, Baton Rouge, and New Orleans; and, strange to say, after exciting an intense feeling of admiration for the many supposable virtues which he must have pos-

sessed when he trod the earth in the days of giants, this gigantic "piece of work," "noble in reason," though "in form and moving" perhaps not exactly "express and admirable," suddenly degenerated into a young mastodon.

Comparative anatomy gave him a setting down. He has taken his position among the quadrupeds, and there he will likely remain.

From all the facts before us concerning man's remains, what is the conclusion?

Man has lived on the earth during the period of superficial accumulations. This is an historical fact.

This period of superficial accumulations already numbers nearly 6000 years. This is also historical.

The fossil remains of an animal are found in the strata of the age in which that animal lived.

The fossil remains of man are found in historical strata, alluvial bottoms, coral coasts, and caverns.

The fossil remains of man are not found in the old formations, the Secondary, or the Tertiary strata.

Therefore, during the ages, long or short, when these strata were deposited, man did not exist.

If there is any fallacy in this reasoning, I would be glad to have it exposed. I have no desire to propagate error.

Argument 4th.—The absence of the remains of animals

cotemporary with man in the same deep-seated strata, leads the mind to the same conclusion.

In many parts of the earth, more especially in the north temperate zone, we find the remains of elephants, horses, oxen, elks, etc. etc., of extinct species. These must not be confounded with the living species of these quadrupeds—although, so far as our present argument is concerned, it would make but little difference, for they are all found in superficial deposits: and, it may be said of the extinct species just mentioned, that they are close upon the heels of their living relations.

The skeletons of camels buried in the sands of Arabia and of the great African desert, may be regarded as fossils of the human period, and the immense quantity of shells in the deltas of rivers, and all through the alluvial plains, may be treated in the same way.

The reasoning we have applied to human remains is applicable to cotemporary mammals, reptiles, birds, fishes, shells, crustaceans, and zoophytes. They are living the life of the Androzoic age. How long it will last Omniscience only knows.

Before the age of man they did not live; their remains are nowhere found in Primary, Secondary, or Tertiary fossiliferous strata. The ages represented by these strata are ages which went before the An-

drozoic animals. Myriads of living forms are found in these strata. To have lived a week or less, and then to have died and be entombed in one vast necropolis, would argue that the Almighty uses his omnipotence to make sport of life.

Argument 5th.—A stratigraphical view of Aqueous Rocks exhibits an Antiquity of the Earth which reaches back at least a million of years.

We mean by a stratigraphical view of rocks, a simple view of stratification by deposit of sediment, without reference to fossils. Bring together in layers of regular succession all the fossil-bearing rocks, and take the vertical measurement, and how many miles will it make? To avoid all dispute, let us call it 5 miles, which is certainly an under-estimate.

Now, to say nothing of upheaval and subsidence, or the deposit of fossils, etc. etc., let us put the question,—How long will it take to deposit about 5 miles of sediment, and then harden the deposit so as to prepare it for upheaval?

Shall we take the calculations of Professors Riddell, and Fushey, and Mr. Lyell, on the Delta of the Mississippi, as the basis of our estimate? If so, then we may make the following calculation:

900 feet : 100,000 years :: 5 miles : 3,000,000 years. The first term of this proportion expresses the united depth of the Mississippi delta and plain—

the second term, the number of years which, by strict calculation, were required to make the deposit of 900 feet—the third term, is the depth we have taken for the fossiliferous rocks—and the fourth term is obtained by the laws of proportion.

Now, lest any one should complain, and say we have no right to make the Mississippi deposit the basis of our estimate, we will just divide the three millions by 3, and put down one million at least. Furthermore, we have said nothing about the hardening of the deposits. We will let that pass. One million will answer for the present.

Here we must notice a criticism of the distinguished Sir David Brewster, touching these great periods of time. In his work, "*More worlds than One*," he alludes to the subject in the following manner:

"That the deposition of strata of such thickness, and operations of such magnitude, required a long period of time for their accomplishment, has been willingly conceded to the geologist; but this concession has been founded on the adoption of a *unit* of measure, which may or may not be correct. It is taken for granted, that many of the stratified rocks were deposited in the sea by the same slow processes which are going on in the present day. Now, although the diurnal changes going on around us,

are very slow and almost imperceptible, yet this does not authorize us to conclude that the world was prepared for man by similar causes operating in a similar manner. *The same physical causes may operate quickly or slowly.*"

This last remark of Sir David is very true; and we now wish to show that he has been guilty of a *suppressio veri*, and consequently, in plain language, a misrepresentation of geology.

Geologists teach that the grand physical causes which have been in operation for so many ages, have acted both *quickly* and *slowly*; but they go a little further than Sir David, who sits in his library and writes handsome books; and by an actual examination of the earth itself, they start the question, and send it round the world of men who have the courage to interrogate nature: *Where do we find physical evidences of physical causes operating QUICKLY—and where do we find physical evidences of physical causes operating SLOWLY?*

The answer comes from every continent and island which has been explored. The grand and stupendous dislocations of the mountain chain afford unquestionable evidence of causes operating "*quickly*"—and the smooth, unruffled, uncontorted, fossil-bearing limestone rocks, resting quietly, conformably, and horizontally under the surface of an immense plain,

afford evidence of causes operating "*slowly*." The strata have been *slowly* deposited—in quiet waters—for there rest the *dead* that have gone down and taken their sepulchres in different layers of the same rock, and not an ocean-wave or current has disturbed them. And then they have emerged by an *upheaval* force operating "*slowly*," for not a fracture can be found.

But I will put *Sir Roderick Murchison* against *Sir David Brewster*, simply observing that while they are both splendid scholars, *Sir Roderick* is a practical geologist, who has not only

"Stood on the Alps — stood on the Appenines ;"

but surveyed them from base to summit with the consummate skill of a philosopher; *Sir David* is a literary gentleman who understands natural magic, and all the dynamics of a lecture-room, but he is not well posted in the science of geology.

In his lecture to the Royal Institution, March 1851, on the former changes of the Alps, he says :

"These grand dislocations—these violent and sudden revolutions from beneath, belong to former epochs of nature, and their magnitude is enormous when compared with any thing which passes under our eyes, or has been recorded in human history. At the same time, geologists have shown upon clear

evidences, that during the long periods which were repeatedly interrupted by great revolutions, there was a constant exhibition of diurnal agencies precisely similar to those which now prevail in the world. There were rains and volcanic forces, and gradual movements of oscillation—moderate elevations and depressions, and long-continued abrasion of mountain sides—and slow but copious accumulation of debris.”

A few words more, and we will bid Sir David good-bye. In the book which we are noticing, he says :

“If the Almighty, since the creation of man, broke up the fountains of the deep and opened the windows of heaven, and thus by apparently natural causes, covered the whole earth with an ocean that rose above the Himalaya and the Andes, why may he not, at different periods, or during the whole course of the earth’s formation, have deposited its strata by a rapid precipitation of their atoms from the waters which suspended them.”

Let us admit, for the sake of argument, that the flood did cover the Andes and the Himalaya; and concede all that is asked concerning the Diluvium or Drift—that is, the sand and gravel, and boulders, and clay banks, etc. etc., found scattered over the earth, were deposited by the *rapid precipitation* of

material from the waters of a quick and powerful deluge, which is taken by Sir David as a model of "*physical causes operating QUICKLY.*"

Now, what is the fact? Scatter this Diluvium over the globe, and it would not cover the surface more than six inches. In some places it is six feet, in some nothing at all. Often it is found as a light covering, varying from two inches to two feet. In our Northern States it is abundant, in our Southern States it is not found at all.

Now remember, it was about one year from the time the waters began to prevail over the face of the earth until the day they abated, and there was dry land.

If, then, a flood from whose waters material would be rapidly precipitated, so as to form a coating for the continents of six inches, occupied a year in producing such a change, how long would it require an ocean of water to make deposits from five to nine miles thick?

We should have 1 yard in 6 years, 6 yards in 36 years, 18 yards in 108 years,—we will say a century,—180 yards in 1000 years, 1800 yards—a little over a mile—in 10,000 years, and 5 miles in 50,000 years—to say nothing of the time required for moderate upheaval.

Sir David is evidently beaten at his own game. He must try his hand again.

Argument 6th.—River Gorges teach that long Periods of Time must have elapsed from the beginning of their Excision down to the Present Time.

The great wonder of the nations, the Falls of Niagara, afford an overwhelming argument for the geologist. In the spray and the rainbow there is beauty, and in the watery precipice and boiling surge below there is sublimity; but in the fearful-looking chasm,—the rocky walls, washed by the mighty torrent,—there, O God of Omnipotence, there I read

“The lesson of thy own eternity.”

The Niagara river flows from Lake Erie over a table-land covered with ancient drift. It is nearly a mile wide at its source, and 330 feet above Lake Ontario, which is thirty miles north-east. The river, for fifteen miles, falls only as many feet, moving mildly along. But bye-and-bye it comes to the Rapids; where, for about a mile, it works itself into a rage; foaming, and frothing, and dashing madly against the little islands, as though it would heave them out of the way for daring to obstruct its course; and thus reaching the verge, it plunges 165 feet into a fathomless abyss.

“Thou flowest on in quiet, till thy waves
Grow broken 'mid the rocks; thy current then
Shoots onward, like the irresistible course
Of destiny . . . waves innumerable
Meet there and madden, and disappear
In thunder and in foam.”

The river is divided into two sheets of water, a little above the Falls, by Goat Island, which, extending itself to the very verge, divides the great cataract into two falls — the American on one side, the Canadian on the other. The American fall is some six hundred feet broad, and one hundred and sixty-five feet high. The Canadian fall is 600 yards broad, and 150 feet in height. After the water has been projected over the falls, it runs with great velocity down a chasm for seven miles, until at Queenstown it passes out from the great gorge, and running on for seven miles further, almost on a level, it enters Lake Ontario.

This ravine or chasm is about 300 yards wide; though we may say it varies in width from 200 to 400 yards. Its depth from the surface to the top of the water is about 250 feet, and the depth of the water varies from 100 to 300 feet.

The heavy, massive strata of cliff limestone, which make the walls of this chasm, belong to the Silurian system, as the fossils plainly indicate; and the escarpment at Queenstown, looking out toward Lake Ontario, called the Queenstown heights, the gorge, the furious river, the cataract, all conspire to tell a wonderful story of the past—one which many cannot believe. But the evidence, to our mind, is plain; the record which the Almighty has made can

be interpreted, has been interpreted. This record tells us of a time far back in the roll of centuries before the creation of our species. It bears upon its very face evidences of antiquity as clear and unquestionable as physical demonstration can afford; and the mind that rejects it is held under a bondage worse than the cruelties of Pharaoh.

The Falls of Niagara were once at Queenstown; and the river has cut its way through "thick and thin" rocks for seven miles.

This is not the mere dogmatism of a wild, speculative geologist. It is the belief of every unprejudiced observer. And we will venture to say that, if the question of time were set aside, no man, learned or unlearned, who would make a careful examination of this gorge, from the cataract to the escarpment, could come to any other conclusion.

Let us make a simple illustration.

In passing along many of our Western and Southern plantations, any one may discover, here and there, a natural trench or gully; or in the wild woods, a very deep and long ravine. Let us suppose we are standing in one of these ravines, fifty feet deep, twenty-five feet wide, and a mile long. Shall we look at the top, both sides, and carefully examine the strata of earth, etc., in regular order, until we get down to the bottom? First, there is

the soil, right and left, one foot. Second, subsoil,—a loose clay, mixed more or less with vegetable matter,—two feet, the same on right and left. Third, heavy, compact, yellow clay, twenty feet, right and left corresponding. Fourth, blue pipe-clay, two feet, both sides alike. Fifth, coarse gravel, five feet right hand, and just the same on the left. Sixth, thin layers of soft, crumbling, ferruginous sandstone, ten feet, sides corresponding. Seventh, coarse gravel again, ten feet, intermixed with clay, and *the beds meeting in the bottom, so as to make one continuous bed.*

Now let us reason. What has made this ravine? Answer, water. How? By washing and wearing away all these layers of clay and sand, etc. Evidently the place was one continuous whole; and there was a time when there was no ravine. The water has scooped it out. The striking correspondence of the layers on the right and left banks show this so plainly that no one could think of denying it. The whole has been formed in fifty years.

To return to Niagara. Take a view of the opposite cliffs. At the top, on either side, you have drift—sometimes called *Diluvium*. Immediately under, you see compact limestone, one hundred feet thick, right and left, corresponding as exactly as the compact clay in our country ravine. Under this

you find soft shales, slate-rock, shaly limestone, etc., etc., one hundred feet, right and left.

What is the conclusion? This Niagara ravine, seven miles long, has been worked out by the action of water, just like the little ravine down yonder in the wild woods of Arkansas. All the dissolving, wearing, transporting, and depositing power of water, has been brought into play in both cases. The difference is a *question of time*. The one has been performed, by the testimony of living witnesses, in the course of fifty years; the other in more than fifty centuries, by the testimony of witnesses of whom it may be said,

“Tho’ dead, they speak in reason’s ear.”

Although the retrograde action has not been absolutely uniform, we may nevertheless approximate an average distance for the annual retrocession. It is estimated that one foot a year is a liberal allowance. We take, then, one foot per annum as our *unit of measure*. If, then, Niagara river cuts away one foot per year of rock, how long has it taken to cut away seven miles? Answer—just as many years as there are feet in seven miles: viz., 36,960.

But what is this, compared with the age of the rocks through which Niagara has cut its way? It is like infancy compared with old age.

The great globe had attained to the fair proportions of land and water, almost as it now appears, before Niagara commenced its course. It commenced by cutting through the superficial drift, which, comparatively speaking, is a modern deposit (pre-Adamite, indeed), but one of the late formations, when compared with the Palæozoic strata. It continued, by working through the solid rocks, century after century, until now it occupies its present position.

Niagara is not a creation, but the development of physical sublimity, proceeding from the operation of physical causes, whose author and executor is God.

The idea of a high antiquity of the great cataract enhances the sublimity of the scene, and the devotional feelings of every beholder who looks up from the Falls to Him who dwells above. He realizes that

“’Tis the voice of the great Creator
Dwells in that mighty fall.”

While his eye is impressed with the beautiful and the sublime, and his ear with the deep tones that come up from the foaming abyss, his thoughts run rapidly back in the bygone years, and his feelings arise to the altar that stands near by the holy of holies. And while impressed with the truth that he

has learned, — that nearly four hundred centuries look down upon him from the heights at which he is gazing, he may take up the exhortatory of David, and say:

“Praise ye the Lord. Praise him from the heavens,
 Praise him in the heights.
 Praise ye him, sun and moon;
 Praise him, all ye stars of light.

 Fire and hail, snow and vapor,
 Mountains and all hills,
 Fruitful trees and all cedars;
 Let them praise the name of the Lord.”

Deeply affected with a sense of the majesty of God, and catching the spirit of the ancient bard; moved by the scene around him, and the reflections of the moment, he must, with most ardent devotion, exclaim:

“*Let Niagara praise the name of the Lord!*”

Argument 7th.—*The growth of volcanoes indicates periods of time — successive periods, the sum of which will exhibit years and centuries of years before the world was ready for man.*

A distinguished writer has compared the mode of increase of a volcanic cone to the growth of an exogenous tree, such as an oak. As the tree grows by the successive addition of cone upon cone of woody

matter, so a volcano enlarges by the successive addition of conical layers of lava.

We may count the rings in a tree and ascertain its age *precisely*, because we know, from observation, that for every ring we may count one year.

We may count the rings or layers of lava of a volcanic mountain, but we *cannot* ascertain its age *precisely*, because “the successive envelops of lava and scoriæ are not continuous as the layers of wood in a tree, and afford us no *definite* measure of time. Each conical envelope is made up of a great number of distinct lava currents and showers of sand and scoriæ differing in quantity, and which may have been accumulated in unequal periods of time.” We may reasonably suppose, however, that any volcanic mountain, which would exhibit countless beds of solid rock and scoriæ, several thousand feet in thickness, must have been erupting and reposing for ages. There are eighty minor cones — lateral vents — on Etna. One of these, only 450 feet high, has been produced within the last 2500 years. Is it not a very moderate supposition to say, that one cone has been brought out every century? Eighty cones would be produced in eighty centuries, or 8000 years. This is only a portion of Etna’s age. There are extinct cones buried under the lava, which has been accumulating during the interval just men-

tioned, and, according to the computation of the best geologists, "the whole must be regarded as the product of the Tertiary epoch," antedating the deep alluvium of the Mississippi. If we examine extinct volcanoes, we shall be enabled to say with certainty, that they had their beginning, progress, and end, at different epochs of the history of the globe—and thus going back, we may trace a succession of volcanoes, co-existing with the successive periods, and often running from one period into another.

When, then, we consider the structure, action, and repose of the hundred prominent volcanoes of the globe—every one bearing its volcanic hills, which have appeared successively, one after another, at least a century apart; and when we are able to trace back volcanic succession to the remotest periods of the old aqueous rocks; who will dare dispute the inference of the geologist, that "they have required an immense series of ages anterior to our historical periods," to act their part in the grand system of physical unity devised in wisdom for the well-being of man?

Argument 8th.—Mountain upheavals, as well as all upheavals, sustain the doctrine of high antiquity. So likewise do subsidences of land.

There are two kinds of upheaval—the gentle and easy, as in the quiet lifting of a cork out of the

bottle by slow fermentation—and the quick and powerful, as the sudden popping of a cork from a champagne bottle.

It is a fundamental principle in geology, established by long observation, that land everywhere has been elevated out of the sea—the sea has not been depressed. The proofs of this have already been adduced.

In mountain-chains we have evidence of both kinds of elevation—the gentle and the violent. The Appalachian chain was upheaved slowly—the Alps, suddenly. But both forms of upheaval demonstrate the lapse of ages. The former indicates an upward movement of miles from the bottom of an ocean to a high position in the air, at the rate of about 50 inches per century; at which rate, it would require at least a half million of years to elevate any mountain of medium height. The latter indicates sudden catastrophes interrupting long periods of repose, as Mr. Murchison has shown in his lecture on the Alps.

Some one may ask, How do we get the 50 inches per century to start on? Well, we derive it as a fair mean of observations made upon the coast of Sweden for 150 years, as well as from similar observations made in various parts of the world.

We insist on the uniformity of nature's laws. Sudden movement is one law—slow movement is

another;—and we feel confident we can tell *when* the first has been executed—and *when*, the second.

As we said before, so we say again—violent contortion, striking faults, and large displacement, with more or less fracture of rocks and mutilation of fossils, clearly indicate the one; and the horizontal rest of strata, with the quiet slumber of inclosed fossils, indicate the other.

Now, if the slow, upward movement of land during historical time be put down by the most eminent men of the continents, at 50 inches per century, who ought to call in question the propriety of making it the basis of an estimate on this subject?

“Perhaps,” says an objector, “perhaps the land might have moved up at the rate of 100 or 200 yards in a century; how can you tell?” In reply, we say:

“What can we reason but from what we know” in reference to all matters connected with physical law? Perhaps there was a time when beautiful Venus tripped lightly round the sun in a very few weeks, and the fiery Mars galloped round in quicker time than Venus, and Jupiter dashed away, took a near cut, and beat both of them.

If, however, we choose to believe in law and order in the material universe, as well as in society—we would say, touching their planetary movements—*perhaps* NOT.

And if the solar system has been in action for countless ages past, (and we believe most astronomers admit this,) we firmly believe that Venus, Mars, and Jupiter, as well as the other planets, have been running their courses during those countless ages precisely as they are going now; and it seems to us unphilosophical to make any supposition contrary to such a belief.

In like manner we believe that, when, under the existing state of things upon our planet, we find two great forms of elevation — the *sudden* and the *slow*, we have found two great types of elevating power, and that by means of these two varieties of the same species of dynamic agent, more especially of the latter, all the land of the globe has been brought up from the deep.

The reasoning of our objector is just as sound as that of the man who contended that Adam was originally a monkey — because it is nowhere asserted that he was not a monkey, and surely God has the power to convert a monkey into a man in the twinkling of an eye.

The suggestion of bare possibilities cannot stand good against the induction of physical facts.

We must adhere, therefore, to the geological creed; because we are not disposed to renounce sound inductive reasoning for wild hypothesis, which stands opposed to all the analogies of nature.

What we have said concerning upheaval may, in a chronological point of view, be applied to subsidence. We have indications everywhere of subsidence of land—slow subsidence, age after age, epoch after epoch. The same rate per century may be assumed here as a basis of calculation, as before, and we arrive at a similar result. The alternations of these two grand phenomena will be shown in our next argument.

Argument 9th.—The Phenomena of Buried Forests exhibit unmistakable Evidences of Long Periods preceeding the Human Era.

In their admirable work on the Fossil Flora of Great Britain, Lindley and Hutton inform us that a large number of the trunks of trees were found in a colliery near Newcastle, in an erect position.

In another place, near Wolverhampton, in the space of a quarter of an acre, the stumps of seventy-three trees, with their roots attached, appeared; and in France discoveries of a similar character have been made.

But the finest exhibition of fossil forests ever yet seen by the eyes of man, may be observed in Nova Scotia. Mr. Logan, the skilful geologist of the province, who, as well as Mr. Lyell, has examined them, reports “*erect trees at seventeen levels, extending through a vertical thickness of 4515 feet of strata.*”

The usual height of a tree, as reported by Mr. Lyell, was from six to eight feet. One trunk was about twenty-five feet long, and four feet in diameter. All of them belong to the coal formation. — *Lyell's Manual*, p. 322.

What conclusion must we form from an examination of these buried forests? Why, plainly, that there have been alternate subsidences and upheavals, together with immense depositions of sedimentary rock, etc.; the whole occupying a period of time whose years, though incalculable, must be regarded as the sands of the sea. We may say millions, but we cannot tell how many.

Can any one doubt it? Surely, it is a plain case. Just commence at the bottom. There you see the fossil trees standing erect. Cast the eye up a short distance, and you see beds of sandstone or coal; a little further up, another row of trees, etc. etc., until you count in one place seventeen distinct forests, and in another fifty-nine, *which have grown one upon another*.

How could this occur? Evidently the first or bottom forest grew up from the surface of the earth until a certain height was attained; then stood for a time; then sank down bodily with the land, *slowly* and *surely* (for they are erect, and no violence has been done to them); then, after sinking down

several hundred feet, the whole was slowly upheaved, after ages had passed away in sedimentary deposit, so that a line drawn some distance above the tops of these trees would mark the surface of the upheaved land; and then another growth of trees, and another subsidence, and another deposition, followed by a second upheaval; and so on, in regular succession, until, as in Cape Breton, we have fifty-nine successive forests.

We make no comment, but pass on to our

Argument 10th. — A Philosophical View of Fossil Remains necessitates the Conclusion of the lapse of immense Ages preceding the Human Epoch.

We have approached the height of the grand argument for, — not the mere oldness of rocks, and sands, and clays, and shells, and bones—we are conscious of nobler conceptions, — but for the majesty and goodness of God, manifested through the great ages which preceded the advent of humanity.

We must ask the reader to look back, and sketch over our chapter on Fossil Remains. Let him, at least, read our twelve propositions, and then return, and we will make a short *résumé*.

When Adam stood up in the garden of Eden, his feet pressed upon the remains of myriads of living forms; his eye may have taken in a scope of country that already entombed ten times myriads, and far

away out of his vision, in the Ural, the Alps, and the Apennines, lay a multitude which no man could number—corals, and shells, and crustaceans, and reptiles, and fishes; enormous saurians and tremendous mammals, scattered over the earth and under the earth, lying in the loose gravel, and imbedded firmly in the solid rock. And all this host of creatures, according to the opponents of geology, had been created, had lived, flourished, and died, and finally were buried, in *two days and a half*.

Let us turn away from the contemplation of such terrible havoc, and look over the lesson which we have learned by “speaking to the earth.”

It must be borne in mind that, according to the facts of the historical epoch, it requires, as a general rule, many centuries for an animal to become extinct.

We read of a noble animal in the book of Job, of whom it was said then, nearly thirty-five centuries ago, “He paweth in the valley, and rejoiceth in his strength; he goeth on to meet the armed men. He swalloweth the ground with fierceness and rage. He saith among the trumpets, Ha, ha; and he smelleth the battle afar off, the thunder of the captains, and the shouting.”

Such is a true picture of the Idumean horse, the Persian horse, the Macedonian horse, the Roman

horse, the charger of Napoleon, and the gallant war-steed of Andrew Jackson. The same may be said of the "innumerable caravan" of mammals, the fish of the sea, and the birds of the air; the same of reptiles, molluscs, articulates, and radiates. They continue unchanged.

In a word, all the species, with a very few exceptions, perhaps, that were created with man, or shortly before him, still live. The extinction of the Dodo, some two hundred years ago, has already been mentioned.

Is it not reasonable, then, to suppose that, when we find buried, in clay, or gravel, or loam, an extinct animal, that animal, or, rather, all the individuals of his species, lived during a period of some five or ten thousand years? It is impossible to avoid the conclusion.

With this principle before us, let us for a few moments look down into the earth, examine the record, and notice the rise and fall of the kingdoms that have passed away.

By dividing and subdividing the different formations, we may, for convenience, make from thirty to forty groups, beginning with the recent, or post-Adamite, and proceeding through, for five miles, till we reach the bottom of the Silurian strata.

Now, if we were to affirm that these thirty or forty groups of strata represent the rise, reign, co-existence, decadence, and extinction of distinct groups of species, we should, so far as the chronological question is concerned, come far within the bounds of truth.

Commencing at the surface, we find the remains of *Man* and his cotemporary inferior animals in recent alluvium.

Proceeding downward, we find, in a post-Pliocene deposit, *shells of living species*; and we have every reason to believe that such deposit took place long before the existence of man. A portion of this post-Pliocene deposit may be seen at various points on the eastern bank of the Mississippi river. It presents itself in the form of bluffs, varying in height from 50 to 150 feet. It may be seen at Memphis, Vicksburg, Fort Adams, and other points. It is an older formation than the alluvial bottom or delta, and it encloses shells of the species *Helix Tridentata*, *Pupa Muscorum*, and *Bulinus* (?)—land shells; and *Lymnea*, *Planorbis*, and *Paludina*—fresh-water shells; all of which are found in abundance in our woods and streams. Some of the existing species, then, have evidently commenced their course during the age of this bluff formation, which appears, from

careful examination, to be the equivalent of the Loess of the Rhine.

We find in this marly bluff deposit, remains of extinct elephants, and mastodons, and other quadrupeds; and by continuing our examination, we find these species also in the Drift or Boulder formation, until we come to a still older group, the Miocene, or Middle Tertiary, where there are no remains at all of the elephant.

It appears, then, that the *Elephas Primigenius* was created some time during the *Drift*, and continued to exist until some time during the period of Mississippi marl bluff. His species must have flourished a vast number of centuries—probably 100,000 years.

Pushing our investigations still downward, we arrive at the Lower Tertiary, or Eocene. Here we find, among others, the *Palæotherium Magnum*; an animal something like the tapir, about the size of a horse. This species began, continued, and expired during the Tertiary.

Proceeding still further, we come to the Secondary range of deposits, and here we find the last of Ammonites in the Upper Cretaceous rocks, and the first of the genus in the Middle Oolite. How many succession of species were created we cannot tell.

In the Wealden, which lies below the Cretaceous, we notice the last remains of the *Pterodactyle*, *Iguanodon*, *Megalosaurus*, *Plesiosaurus*, etc., large reptiles of various species, the most of which appear to have had a cotemporary existence throughout the Wealden and Oolite periods; and it was during the latter period they were created. Not a vestige of their remains can be found, above or below the strata designated.

In the Lias and Trias groups we find species which cannot be found in the Oolite above or the Permian below. The latter has its organic remains wholly different in species from the Carboniferous formation below it—and in this Carboniferous and coal-bearing series we find the last of the Trilobites, several successive species of which had their generations in the Devonian and Silurian divisions of the Palæozoic age. To any unprejudiced mind, this argument must be convincing. We deem it unnecessary to add another word.

It is a moderate estimate to say there have been 50 successions, or (to express the idea differently,) 50 successive creations of animals, from the lowest Silurian crustacean to man; and it is equally moderate to say that every succession lived 10,000 years. The reader can multiply for himself and look at the figures.

In conclusion, it must be borne in mind that the long periods of repose — together with the time for upheaval and subsidence — all these have not been taken into the estimate in our last argument. The repose and the vertical movements were, in part, synchronous with the life of the species; but we have no means of ascertaining how much longer those movements may have occupied.

We have closed our ten arguments. If the reader is not satisfied concerning the high antiquity of the globe, we respectfully suggest that he shall study geology for five years; and we risk our judgment that he will then be a convert.

Will any one ask, Why should the Almighty occupy so much time in preparing the world for the abode of man? We answer, Why should he have occupied so much time (4000 years,) in preparing the world for the advent of the Messiah? And, again — When God speaks by his works, “Who art thou, O man! that repliest against God?” — shall the thing formed say to him that formed it, “Why hast thou made me thus? Why didst thou not make every thing at once? Surely thou hast the power.”

There is no end to unwise questions.

If God in his wisdom chooses to occupy 4000 years in the development of a moral plan for the

good of man, we see no reason why he may not have occupied myriads of years for the development of a plan which involves physical, moral, and intellectual power, and which, (as we earnestly believe,) contemplates the *earth* as it is, the abode of man in his mortal state — the *earth as it will be* — the abode of man in his immortal state.

CHAPTER XXI.

Noah's Deluge — Proposition — Noah's Deluge was an Intra-Asiatic Flood.

IN the year 1837, soon after receiving my medical diploma, I was very deeply interested in studying the Natural History of Man. Among other works, I carefully examined Lawrence's Lectures, with which I was delighted.

I expressed myself highly pleased with the book, to the Professor of Materia Medica, in one of our western colleges, when he immediately curbed my admiration, by saying in most emphatic tone: "Take care, take care, my young friend; Lawrence is an infidel."

"An infidel," replied I; "how do you make that out?"

"Why, just listen to what he says about Noah's ark," and thereupon he turned over the leaves and read as follows: "I have only to add, that the repre-

sentations of all the animals being brought before Adam in the first instance, and subsequently of their being collected in the ark, if we are to understand them as applied to the living inhabitants of the whole world, as zoologically impossible."

"Now," continued the Professor, "if that is not infidelity, I cannot tell what infidelity is."

I thought so, too, and I laid Lawrence on the shelf, and pronounced him a bad man. Since that time I have had occasion to confess my ignorance; and I am well convinced that the Professor was by no means thoroughly informed upon all the collateral points of science connected with the great catastrophe of Noah's flood, or he would not have pronounced so vehemently upon the moral character of the distinguished lecturer.

When my attention was next directed to this subject, I undertook to make a lecture on the Flood, before a Lyceum. I had not gone far in my preparation before I discovered my utter incompetency. I therefore declined making an exhibition of my ignorance, and begged for further time. It was readily granted—the matter was indefinitely postponed, and I have never yet delivered the lecture.

The object of the lecture may be seen from reading the following note:

“MT. PLEASANT, May 18th, 1842.

“DEAR SIR, — The undersigned, a committee appointed by the Mt. Pleasant Lyceum, respectfully request you to deliver a lecture on the Geological Proofs of the Flood, at your earliest convenience.

“Yours truly,

WM. THOMSON,
THOS. SHARP.”

I continued my investigations, by searching for knowledge among the commentators. I examined Henry, Scott, Benson Clark, and others, and found that they had never examined the subject. They took for granted, as true, what geology now disputes—that the waters covered the entire globe, and that all the representatives of the terrestrial species of inferior animals were, by some Divine power, brought into the ark, and preserved during the period of the flood.

The Polar bear came from his icy home in the frigid zone, subdued to tameness, and accommodated to a latitude of 40° North, by miraculous agency. The lion of Africa, came from his torrid abode, and, by the same great power, was brought into immediate subjection. The kangaroo of New Holland, the bear of Russia, and the elephant of Asia, joined in the procession, led by their Maker, or impelled by his irresistible power.

One of these distinguished interpreters remarks: “He who at first brought them to Adam to name

them, now brought them to Noah to preserve them," and all the rest endorse the opinion. To a man of large credulity these commentaries are very satisfactory — but to one, who is determined to investigate for himself, they afford very small comfort.

After several years of careful study, I am well convinced that the popular ideas of the Deluge are incorrect; and that, so far from sustaining truth, they are eminently calculated to sustain infidelity. The infidel objections to the Flood have never been answered by any theologian who attempts the defence of the popular opinion; and the only possible way of removing the cavils of the sceptic, is to take the true position, and fearlessly declare that the *Flood of Noah was a local deluge*.

We propose to devote this chapter to the defence of this position; and, in order that we may lay off our work to advantage, we submit the following seven propositions:

1. *A universal deluge is a physical impossibility.*
2. *There is no geological proof of Noah's Deluge.*
3. *The proof of the Deluge, outside of the Bible, is traditional.*
4. *The dimensions of the ark could not possibly accommodate all the species of land animals on the globe.*
5. *"All the earth" is frequently used in limitation, as may be seen by reference to several texts; and it may be*

used in a limited sense by Moses, in giving a description of the Flood.

6. *The moral design of the Deluge sustains this view of the subject.*

7. *The explicit declarations of the Apostles Paul and Peter show plainly that the Deluge was limited to a local KOSMOS.*

We have not assumed these propositions for the purpose of defending any system; but we have patiently arrived at the truths they express by a diligent search for the truth.

Proposition 1st. — A universal Deluge is a Physical Impossibility.

No intelligent mind, of unbiassed feelings, will dispute the truth of this proposition. Regarded as a physical phenomenon, and contemplated in the light of physical laws, such a cataclysm as the waters of the ocean covering all the mountains of the whole globe must be deemed impossible. We believe all candid men will admit this without debate.

Did the Almighty perform a miracle, and thereby, suspending physical law, heap up the waters from the deep, and pour them down from heaven, until the Alps, the Apennines, the Andes, and the Alleghenies were covered?

Good and great men, by the thousand, have reve-

rently answered, *Yes*. We reverently answer, *No*; for, notwithstanding we believe in miracles, — yea, further, that there was miraculous power in the Flood,—we cannot, from all the evidence before us, subscribe to the popular idea of a universal deluge.

Twenty years ago, the following paragraph was denounced by a host of preachers as intolerable infidelity. At present it is somewhat orthodox — that is, all orthodox clergymen who understand geology readily subscribe to it.

“The doctrine of a universal deluge is unphilosophical; because, even admitting that there is a sufficient quantity of water in the sea to produce such a deluge, still, no adequate cause can be assigned for such mighty effects. But allowing a cause which might have moved the whole ocean out of its bed, and cast it upon the land, still, such an effect could not have been produced as a universal flood; since it would have required many times more water than exists on the whole earth, to have covered all its mountains at the same time.”

The deep sea soundings which have been made by the officers of the United States navy, show the greatest depth of the ocean to be about 25,000 feet. The Atlantic is nowhere, probably, more than 10,000 feet, and in many places does not reach 5000 feet. Let us suppose the average depth of the ocean

to be 12,000 feet. Now observe that Mount Kunchingua, the highest peak of the Himalaya range, is upwards of 28,000 feet above the level of the sea. How could all the water of the ocean rise high enough to cover that mountain? A *forty days' rain* all over the globe, together with all the water of the ocean, could not produce a flood that would cover a mountain five miles high. Again, it must be observed that if the water of the ocean could be lifted out of its bed, and all of it heaved up in a column upon the land, then the bed of the ocean would be left dry. This bed has its mountains, hills, valleys, and plains; and so we should have a mere moving of the water from one place to another. And where, I ask, is the universal deluge? It is only in the imagination of men.

Let us here refer to the Bible, and ascertain what God himself has said about the sea.

“Where wast thou when I laid the foundations of the earth? . . . Who shut up the sea with doors when it broke forth, as if it had issued out of the womb? When I made the cloud the garment thereof, and thick darkness a swaddling band for it, *and established my decree upon it, and set bars, and doors, and said, Hitherto shalt thou come, but no further, and here shall thy proud waves be stayed.*”

Now, according to the popular idea of the Flood,

“the bars and doors” broke loose, and the “proud waves” of the ocean played in awful sublimity over the heads of Chimborazo and Mont Blanc. If so, the decree was revoked, and we are brought to inquire the meaning of that passage which says, “I am the Lord. I change not.”

But the objector will insist that the omnipotence of the Creator was fully adequate to fill up the ocean as fast as it was heaved upon the dry land, and thus keep up a full supply of water.

We might admit the truth of this as an abstract question, but abstractions will not answer the purpose. We may conceive that God has power sufficient to blot out the sun in an instant, and leave a poor race of mortals to grope about in the dark for a while, and then restore the sun, and cause it to shine so brilliantly that every poor creature on the earth would be struck with blindness. This is the imaginary omnipotence of a dreamer, but not the real display of a God of goodness and wisdom.

It is not enough to say Omnipotence may perform a certain act. Did he ever actually perform it? Would it be consistent with his attributes to make such a display of his power? Yea, further—would it exhibit his glory? These are some of the questions which should be asked by every candid inquirer for truth. God is *able* to translate us all to

the skies, as he did Enoch. Will he do it? No. For he has decreed that we must die, and be resurrected. His power is regulated by his law.

In no instance of miracle on record in the Bible has a single law of nature been violated. God cannot violate his own laws. And when, by an agent, he performs a miracle, he does an act independent of the laws of nature. The miracle goes on, and the laws of nature go on, simultaneously. Miracle is an insulation of Divine power, and not the conflict of God with himself.

From all these considerations, we argue that, as the Almighty originally passed the decree that the ocean should keep its bed, notwithstanding, by tides and currents, and volcanic heavings, and the throes of the earthquake, it might *inundate considerable territory*, it is highly probable he never has performed the miracle of flooding the whole globe at once. In a natural point of view, it is a physical impossibility. In a moral point of view, it is a miraculous impossibility.

Proposition 2d. — There is no Geological Proof of Noah's Deluge.

What a waste of words has been made by thousands of good men, in attempting to prove, from the earth itself, that the waters of the flood extended over the entire globe!

How often have we heard that "the solid rocks themselves proclaim aloud the truth of the Noachian Deluge, by the petrified shells which they contain!" One moment's reflection would show that the solid rocks had the shells fast enclosed in them before the flood came—that underneath the ark, when it floated over Ararat, were the unaltered strata, holding thousands and millions of organic remains.

But what shall we say of the immense deposits of sand, gravel, loam, and prodigious boulders, scattered over the Northern hemisphere?

Did not Dr. Buckland, the able geologist, refer these as well as the bone caverns found in some parts of the earth, to the action of the flood?

Yes, he did for some years; but as soon as he discovered his mistake he renounced the theory. To use the language of one of his intimate friends, "he abandoned at once his early and cherished opinions as regards the geological proof of the Deluge, when further examination and new discoveries had convinced him of their fallacy."

All this drift, as we have heretofore seen, is referable to the agency of glaciers and icebergs during a period which elapsed, ages upon ages, before the creation of man.

Professor Hitchcock has been quoted by some of our pulpit orators, as though he were an advocate

of a universal deluge and its geological proof. The following is a specimen: "All the diluvium which had been previously accumulated by various agencies, has been modified by a powerful deluge, sweeping from the north and north-west over every part of the State (Massachusetts,) not excepting the highest mountains."

Dr. Hitchcock here alludes to a local pre-Adamite deluge. He can speak for himself with regard to the flood of Noah. He says, in the last edition of his Geology: "Nearly all geologists have come to the conclusion, without denying the occurrence of this event, that no certain marks of it are now to be discovered."

The following animals have been reported "destroyed by the deluge:"

Elephas Primigenius.—Primitive Elephant—found in various parts of Europe, and in the northern parts of Asia, and in the northern parts of North America.

Mastodon Maximus.—Great Mastodon, found in Ohio, Kentucky, New York, etc., has tusks like the elephant, and is sometimes called the Mammoth.

Hippopotamus Major.—Great Hippopotamus, found in Germany and England.

Hippopotamus Minutus.—Little Hippopotamus, found in France.

The *Rhinoceros*, the *Tapir*, the *Great Elk* of Ireland, the *Ox*, *Hyena*, *Horse*, Jefferson's *Megalonyx*, and the *Megatherium* of Buenos Ayres, make up the list.

To one who has even a superficial knowledge of the structure of the earth, the foregoing tabular arrangement is very amusing.

Here we have animals of different periods, which were in reality buried at various times, represented as cotemporary, living all together a few days before Noah went into the ark.

The truth is, Noah never saw the Primitive Elephant in his living attitude. He may have walked over his bones in some of his rambles towards the north of Asia. Of this we have no certain information, but we do feel quite certain that none of these animals became extinct by the flood. We will give a good and sufficient reason for our faith, by asking one or two questions, after making a preparatory statement. According to the sacred history, there were millions of human beings drowned in the flood; there were millions of land animals, embracing nearly 2000 species of quadrupeds, 6000 species of birds, (that being the number which cannot swim,) more than a thousand species of reptiles, and more than 20,000 species of insects, (at a mode-

rate estimate,) whose bodies are capable of being fossilized.

How does it come to pass, that a warm advocate of the universality of the Deluge, and of its geological proofs, can enumerate only a dozen species of animals destroyed by that catastrophe? How does it occur that no human remains are found with lions, tigers, elephants, and mastodons?

If they were all in one grand diluvial "burial blent," why do we not find them *blent*?

The truth is, we do not find them at all. There are no marks of the deluge left. There is no geological evidence of such a cataclysm. We must believe it upon other evidence. What has become of the bones of the deluge we cannot tell. Possibly, they are lying at the bottom of the Indian Ocean, or lodged in the branches of a "coral tree;" but we do insist, if anybody has found an *elephant* he shall likewise produce a *man*.

Proposition 3d. — The proof of the Deluge outside of the Bible is traditional.

We have in the Bible itself some very good proof besides the narrative in Genesis. It requires no argument to convince the Christian that there were such persons as Paul and Peter. They are honored everywhere as beloved apostles. Further, it requires no long course of reasoning to persuade him that

the Saviour once lived in Palestine; that there he lived, labored, and died.

We have the testimony of the two former, speaking by inspiration, and we have the testimony of the latter, who is the express image of God himself, and of whom it is written he knew all things.

We give the passages.

The Testimony of Paul. — “By faith, Noah, being warned of God of things not seen as yet, moved with fear, prepared an ark to the saving of his house; by the which he condemned the world, and became heir of the righteousness which is by faith.” HEB. xi. 7.

The Testimony of Peter. — “The long suffering of God waited in the days of Noah while the ark was preparing, wherein few, that is, eight souls were saved by water.” 1 PET. iii. 20.

“For, if God spared not the old world, but saved Noah the eighth person, a preacher of righteousness, bringing in the flood upon the world of the ungodly,” etc. 2 PET. ii. 5.

. . . “The earth standing out of the water and in the water whereby the world, that then was, being overflowed with water, perished.” 2 PET. iii. 5 and 6.

The Testimony of Christ. — “For, as in the days that were before the flood they were eating and drink-

ing, marrying and giving in marriage, until the day that Noah entered the ark, and knew not until the flood came and took them all away; so shall also the coming of the Son of man be." MATT. xxiv. 38, 39.

Tradition. — Berosas, the Chaldean historian; Hieronimus, the Egyptian historian; and Abydemus, an Assyrian historian; all speak of a flood about that time. Plato, and Plutarch, and Lucian, and other Greek writers, make mention of Deucalian's flood, which is supposed to be the same as Noah's.

These traditions are intermingled with fable, and they are not reliable. Take them, however, at the best estimate, and they do not prove a universal deluge.

It is very probable that some of those old historians may have entertained the opinion that the flood embraced the globe; but this is no proof—it is mere opinion, and stands side by side with the boy's notion of his father's farm—that it was the largest place on the face of the earth, and that the angels lodged in the branches of the trees.

Proposition 4th.—*The dimensions of the ark could not possibly accommodate all the species of land animals.*

The dimensions of the ark were 300 cubits in length, 50 in breadth, and 30 in height, and it embraced three floors. Now, although it might be

admitted that all species of animals were brought from all parts of the globe to Noah by miracle, does it not appear, from the face of the narrative, that they were to be preserved by natural means? *All kinds of provisions were taken aboard, to keep them alive.* Let this be borne in mind. Still further, that this provision was to last for 375 days, at least. Now, when it is considered that there are nearly 2000 species of land mammals, 5000 species, and upwards, of land birds, and 2000 species of land reptiles, besides twenty or thirty thousand species of insects—when it is considered that, on a fair average, an animal will eat his own weight every three months—it will be seen that, *according to the natural laws of subsistence* given to Noah (Gen. vi. 21), the ark was rather small.

These are insuperable difficulties. The only way to avoid them is to adopt the geological theory, that the Flood was local, and all the operations of Noah circumscribed to the locality of the inundation.

Proposition 5th.—“*All the World*” is frequently used in Limitation, as may be seen by reference to several Texts; and it may be used in a Limited Sense by Moses, in giving a Description of the Flood.

The biblical student is well aware that in numerous instances,—as, for example, in Is. vii. 24, x. 14,

Jer. i. 18,—it is used to designate the land of Palestine.

I desire to notice particularly the following passages :

Dan. x. 1: "Nebuchadnezzar the king unto all people, nations, and languages, that dwell in *all the earth*." Here it is applied to the Assyrian Empire.

In Dan. vi. 25, it is used to designate the empire under King Darius.

In Dan. ii. 39, it evidently has reference to the Macedonian Empire.

In Luke ii. 1, we read "that there went out a decree from Cæsar Augustus that *all the world* should be taxed." Here the phrase "all the world," as in numerous places in the New Testament, means the Roman Empire — *oikoumenee*, habitable world.

I will cite one or two more.

Rom. i. 8: "Your faith is spoken of throughout the whole world." Here *Kosmos* is employed to designate the same Roman Empire.

Also Cal. i. 6: "The gospel is come unto you, as it is in all the world" — *Kosmos* again.

In the 23d verse of the same chapter, the Apostle says the gospel "was preached to every creature which is under heaven;" and the history of his own labors, as well as his own declarations, show very

plainly that he meant the dominions of the Roman Emperor.

On philological grounds, then, there seems to be no difficulty in the way of the geological theory.

The Hebrew word *Ha-eretz*, means the whole planet, and also means a part of it.

The Greek word *Kosmos* means the universe—order—arrangement—an empire—a constitution of things; and, as used in the New Testament, is clearly defined by *oikoumenee*, the habitable earth, or rather the inhabited region belonging to the Roman government.

In this stage of our investigation, then, we say that Moses might have employed the expressions “the earth,” “all the earth,” and all the hills “under the whole heaven,” to have designated a limited region of country; for, in so doing, he would have spoken as inspired men after him, in every age, to the death of the Apostles, have spoken, in order to mark out and define certain territories, occupied by certain people, governed by certain laws.

Let us proceed to the next stage of our inquiry.

Proposition 6th.—*The Moral Design of the Deluge sustains this View of the Subject.*

What was the moral design of the Deluge? To punish the wicked, and to preserve the lineage of

the Messiah. Was it necessary to send a universal deluge, to effect these objects? Men had become very depraved. God had borne with their wickedness until he was determined to bear with it no longer. It was necessary to separate the wheat from the chaff—to introduce one of his appointed means, for the purpose of adhering unalterably to his promise concerning the Messiah. It was a grand, destructive providence, intended to promote the good of the coming nations, and the glory of their Sovereign.

And here it must be observed that these two purposes were all that God had in view. In the great revolutions of our globe antedating the deluge, we see clear evidences of the skill and wisdom of the Divine Builder, fitting up a habitation for man. In the Deluge of Noah there is nothing of the kind. It was not intended for the purpose of tearing up rocks, and floating off gravel, and extinguishing mastodons; but to punish wicked men, and to preserve the progenitors of the Saviour of the world.

We are now ready for our last proposition.

Proposition 7th. — The explicit Declarations of the Apostles Paul and Peter show plainly that the Deluge was limited to a Local Kosmos.

I ask of all my readers who can read the Greek, to examine with care 2 Pet. iii. 5-6 :

“For this they were willingly ignorant of that by the word of God the heavens were of old, and the earth (*Gee*) standing out of the water and in the water; whereby the world (*Kosmos*) that then was, being overflowed with water, perished.”

Here is a most remarkable change of terms from *Gee* to *Kosmos*. The word *Gee* usually means the *land* of the globe, in contrast with the *sea*.

Now, the Apostle describes the relative position of land and sea at the time of this catastrophe, and then remarks, “whereby the *Kosmos* that then was” —not the whole *Gee*—“being overflowed with water, perished.”

Let us see if we can ascertain the limit of the “*KOSMOS that then was.*”

The same Apostle, in the second chapter of the same epistle, fifth verse, says, “For if God spared not the old world (*archaion Kosmos*), but saved Noah, the eighth person, a preacher of righteousness, bringing in the flood upon the *world of the ungodly* (*Kosmoo aseboon*).”

We have found it. It was the *kosmos of the ungodly* that was overwhelmed with water—the wicked people to whom Noah preached, and the land which they inhabited.

The Apostle Paul’s statement (Heb. xi. 7) closes our quotations.

“By faith, Noah, being warned of God of things not seen as yet, moved with fear, prepared an ark to the saving of his house; by which he *condemned the world* (*Katekrine ton Kosmon*), and became heir of the righteousness which is by faith.

Shall we present the argument in the form of a syllogism?

1. Noah's Flood overwhelmed the Kosmos of the ungodly.

2. The Kosmos of the ungodly embraced a portion of Asia.

3. Therefore Noah's Flood extended over a portion of Asia.

I now beg leave to introduce the following extract from the work of Dr. John Pye Smith, quoted by Dr. Hitchcock, in his admirable treatise on the “Religion of Geology.” It may be proper for me to remark that the foregoing short essay on the Flood was prepared some years ago, before I had the pleasure of reading Dr. H.'s book; and still further, that I have never seen Dr. Smith's book, the title of which is “Relation of Holy Scriptures to some Parts of Geological Science.”

Dr. J. Pye Smith on the Flood.—“Let us now take the seat of the antediluvian population to have been in Western Asia, in which a large district, even at the present day, lies considerably below the level of

the sea. It must not be forgotten that six weeks of continued rain would not give an amount of water forty times that which fell on the first or a subsequent day; for evaporation would be continually carrying up the water to be condensed, and to fall again, so that the same mass of water would return many times. If, then, in addition to the tremendous rain, we suppose an elevation of the bed of the Persian and Indian Seas, or a subsidence of the inhabited land towards the south, we shall have sufficient cause in the hands of Almighty justice for submerging the district, covering its hills, and destroying all living beings within its limits, except those whom Divine mercy preserved in the ark. The drawing off of the waters would be effected by a return of the bed of the sea to a lower level, or by the elevation of some tracts of land which would leave channels and slopes for the larger part of the water to flow back into the Indian Ocean, while the lower part remained a great lake, or an inland sea—the Caspian.”

It is highly probable that volcanic agency and earthquakes played an important part in the Noachian Deluge, and the whole may have been regulated—doubtless was—by the immediate miraculous power of the Almighty.

One remark concerning Ararat, and we have done.

It is not at all probable that the present Ararat, 40° North latitude, is the mountain on which the ark rested. "We are informed," says Dr. Hitchcock, "by Jerome, that the name Ararat was given generally to the mountains of Armenia, and long before geology existed, Shuckford suggested that some spot further east corresponds better with the scriptural account of the place where the ark rested. For, it is said of the families of the sons of Noah, that as they journeyed from the east, they found a plain in the land of Shinar. Now, Shinar, or Babylonia, lies nearly south of the Armenian Ararat, and the probability therefore is, that the true Ararat lay much further south. The olive leaf brought to Noah by the dove indicates this; for the Ararat of 40° North is too cold a climate for the olive.

In conclusion, I would earnestly invite all ministers of the gospel who have not examined this question, to give it their special attention.

CHAPTER XXII.

The Bible and Geology—The Conflict and the Reconciliation.

ALL the great errors existing in the popular mind touching science and revelation, may be traced back to two great sources—*wrong translation and wrong interpretation*. The enlightened scholarship of Europe and America has demonstrated this to the satisfaction of every candid inquirer for truth.

For more than forty years there has been a *conflict*, NOT between Scripture and Geology, but between Geology and erroneous views of Scripture. And the *reconciliation* is taking place—NOT between the Bible and Geology, for they have never quarrelled—but between Geology and those who once opposed it.

Furthermore, it is quite evident, that as the conflict arose because of the misconceptions of the sacred record, so the reconciliation must be effected by enlightening the mind, and thus enabling it to take a true conception of the book divine.

We believe the Bible is the Word of God.

We believe the earth is the material work of God.

We believe Geology is "a true copy from the original record"—the earth itself. Hence it follows: We believe that God in his word cannot contradict God in his work, and that Scripture and Geology go hand in hand in the great demonstration of divine goodness.

Several schemes of harmony have been proposed by distinguished scholars, in order to remove any doubts and fears that might exist in the minds of believers concerning the truth of the great physical science of modern times. Two of these schemes deserve our attention.

The first proposes to consider the days of creation as extended periods of time. The advocates of this method state that there is a coincidence between the successive creations of vegetables and animals and the appearance of fossil forms in the rocks. We have examined this plan with care and without prejudice; and, although captivated by the eloquence of Hugh Miller in its defence, we have been compelled to reject it.

It does not seem to be sustained by facts.

Animals and vegetables are commingled in the most ancient strata of fossiliferous rocks, and they are commingled in all the strata, young and old.

We refer the reader to our Chapter on Fossil Remains, Propositions 5th, 6th, and 7th.

The second scheme was proposed some forty years ago by two eminent men about the same time—Dr. Chalmers and Dr. Buckland.

We present it in their own words.

Dr. Chalmers, in his evidence of the Christian revelation, says: "Does Moses ever say that when God created the heavens and the earth He did more, at the time alluded to, than transform them out of previously existing materials? Or, does he ever say that there was not an interval of many ages between the first act of creation described in the first verse of the book of Genesis, and said to have been performed at the beginning, and then more detailed operations, the account of which commences at the second verse, and which are described to us as having been performed in so many days? Or, finally, does he ever make us to understand that the genealogies of man went any further than to fix the antiquity of the species and, of consequence, that they left the antiquity of the globe a free subject for the speculation of philosophers."

Dr. Buckland says: "In my inaugural letter published at Oxford, 1820, I have stated my opinion in favor of the hypothesis, which supposes the word *beginning*, as applied by Moses in the first verse of

the book of Genesis, to express an undefined period of time, which was antecedent to the last great change that affected the surface of the earth, and to the creation of its present animal and vegetable inhabitants; during which period a long series of operations and revolutions may have been going on, which, as they are wholly unconnected with the history of the human race, are passed over in silence by the sacred historian, whose only concern with them was barely to state that the matter of the universe is not external and self-existent, but was originally created by the power of the Almighty."

This view of the subject has been embraced by a large majority of Christian geologists. It has been ably sustained by pure translation and accurate criticism. Harris, J. Pye Smith, Sedgwick, Pusey, Whewell, Silliman, and Hitchcock, have all contributed their talents and learning in its defence, and we have no question of its correctness.

The views of these able men have been admirably condensed and presented in ten propositions, by *Dennis Crofton, A. B.*, in an article in *Kitto's Journal of Sacred Literature*, and republished in a small volume some three years since.

Mr. Crofton has extended the Scriptural investigation further than any one who has gone before him. He has elaborated the philological branch

of the argument in a masterly manner, showing clearly that the *usus loquendi* of the words and phrases employed by Moses in Gen. i., supports the theory of Chalmers and Buckland.

Commending the volume to the reader's careful perusal, we beg leave to submit the author's ten propositions.

I. "That the absolute age of our earth is not defined in the sacred volume.

II. That there may have been a long interval in duration between the creation of "the heaven and the earth," mentioned in the first verse of the first chapter of Genesis, and the continuation of the earth's history in the second verse.

III. That the term, "the earth," (Heb. *Ha-eretz*,) does not apply necessarily, in every instance, to the whole of our planet, but sometimes only to a part of it.

IV. That the state of the earth described in the second verse, as without form and void, (*Tohu va bohu*,) does not necessarily mean matter never reduced to form and order, but may signify matter reduced to disorder, after previous organization and arrangement.

V. That the "darkness upon the face of the deep, also mentioned in the second verse, is not

negative of the previous existence of light, but may have been only a temporary one.

VI. That the commencement of the account of the first of the six days of creation dates from the beginning of the third verse: "And God said, Let there be light."

VII. That the act of the first day does not necessarily signify the creation of light, but may have been only the calling it into operation upon the scene of darkness described in the second verse.

"VIII. That the calling the light day, and the darkness night, with the declaration that "the evening and the morning were the first day," does not necessarily imply that this was the first day, *absolutely* speaking.

"[The original reads, 'And the evening was, and the morning was one day.']

"IX. That the work of the second day, mentioned in the sixth, seventh, and eighth verses, may have been only an operation performed upon the atmosphere of our earth.

"X. That the work of the fourth day does not necessarily imply that the sun, moon, and stars were then first created, or formed for the first time from pre-existing matter; but may only have been that they were then, for the first time in the detail of the history of the present earth, made visible to

it, and ordained to their offices with respect to the coming human creation.

“The work of the third, and the fifth, and the sixth days, simply refer to the creation of existing species.”

Mr. Crofton supports his propositions by the induction of more than one hundred passages of Scripture.

From all our reading, reflection, and observation, for many years past, we believe the truth concerning the first chapter of Genesis may be expressed in the five following statements:

1st. The first verse of the first chapter of Genesis announces the original creation of all things — the entire universe, including our earth. *God created.*

2d. Indefinite ages passed away, during which all the facts and phenomena brought to light by geologists may have occurred.

3d. All that portion of the narrative concerning inanimate objects, such as *light, darkness, firmament, and lights* in the firmament, has no reference to *creation*, but to *appointment, ordination, setting apart.*

God *arranged* and *appointed* these things for the use of the approaching animal and vegetable kingdoms.

4th. All that portion of the narrative which treats of animals, and vegetables, and man, is clearly an

account of a *creation* of species — such as had never existed before.

5th. This “appointing and ordaining” inanimâte things to their appropriate functions, and this *creation* of species coetaneous with such appointments, agree with the great developments of the earth. At the introduction of every great age, the spirit of God has moved upon the face of the deep, and *new species have been created*.

The next place of conflict is the Deluge.

We have endeavored, in our chapter on this subject, to show that the New Testament writers tell us the boundary of the Flood, and that all the mistakes which men have made about it evidently have grown out of inattention to the use of one Greek word — that word is *Kosmos*.

It is not necessary to add anything more to the subject in this place, and we proceed to notice another battle-ground — Death.

The Bible teaches, say they, that sin is the cause of death everywhere; whereas, geology teaches that death was introduced ages before man’s creation.

We answer, the Bible does not teach any such doctrine. It says nothing about the relation of sin and the death of inferior animals. It is a curious weakness of great minds to form such a strange conception.

Here is the plain teaching of an inspired apostle upon this point:

“Wherefore, as by one man sin entered into the world, and death by sin; so *death* passed upon ALL MEN, for that all have sinned; that as sin hath reigned unto death, even so might grace reign through righteousness unto eternal life by Jesus Christ our Lord.”

Humanity, human death, human transgression, and human salvation, are the topics of Paul's argument. Rom. v. 12-21.

Again, in 1 Cor. xv. 22, 23, the same inspired teacher says: “As in Adam all die, even so in Christ shall all be made alive. But every *man* in his own order,” etc.

The doctrine of the opponents of geology on this subject seems to me to necessitate a resurrection of brutes, fishes, birds, snakes, lizards, insects, oysters, and zoophytes.

If they “all died” by reason of Adam's sin, why must they not all be made alive in Christ?

This is carrying speculation a little beyond the point attained by the wildest geologist.

The last ground of warfare is found in the passage 2 Pet. iii. 7. “But the heavens and the earth which are now, by the same word are kept in store, reserved unto fire against the day of judgment, and

perdition of ungodly men." Also 2 Pet. iii. 10: "The elements shall melt with fervent heat; the earth also, and the works that are therein, shall be burnt up."

It is affirmed that the Bible teaches the complete burning up or annihilation of the world; but that geology, by insisting on countless ages heretofore, conveys the idea that the countless ages will continue.

Well, suppose it does; what then? Do we make the Word of God of no effect? By no means. We magnify it, and make it honorable.

The Bible nowhere teaches the annihilation of the world. It may be burnt, but for what purpose? To purify it, to renovate it, to fit it for the abode of immortals.

The Flood did not consume or annihilate the world; although Peter remarks, "The world that then was *perished*." So, too, the fire (admitting the literal interpretation) will change the present aspect of things, and prepare the world for the habitation of righteousness.

We believe the earth will remain, *purified by fire*, move round its centre, the sun, and that all the members of the solar system will continue to revolve in their orbits, throughout the ceaseless ages of

eternity. We find nothing in the Bible to contradict a faith like this—so cheering to the heart of the humble believer in the promises of God.

We will not allude to the figurative interpretation of these passages, simply because we deem it unnecessary

CHAPTER XXIII

The Benevolence of God, and the Unity of his Plans, argued from the Structure of the Earth.

THE most prominent and popular of the Bridgewater Treatises is the work of the eminent Dr. Buckland, entitled "Geology and Mineralogy, considered with reference to Natural Theology." The arguments adduced in this work to demonstrate the power, wisdom, and goodness of the Creator, present an array of facts and reasoning calculated to make a deep impression on the mind; and he who can rise from the examination of the treatise and not feel that he has partaken of an intellectual banquet, must be incapable of appreciating the "good, the true, or the beautiful."

We were rejoiced to obtain a late edition of this work by his son, Francis T. Buckland, and we sincerely trust it will have a wide circulation. The original work, published in our country in 1836, was regarded by all competent judges as the first systematic essay on the subject of which it treats;

and now, while both editions are lying before us, we are constrained to say, first, last, and best.

The remains of the venerable author rest in Islip church-yard, but his name will live in the memories of the sons of science, as a great expounder of the physical constitution of our globe.

The arguments of the Christian geologist in support of certain great truths of revelation, are comprehensive, and peculiar to the science which he defends. They are comprehensive, because they embrace a view of the Divine Being in all his works on earth before and since the creation of man. They are peculiar, because no such train of reasoning can be found elsewhere.

The discoveries of science are calculated to enlarge our conceptions of the Divine character as expressed in his Word, and if astronomy enables us to find out the beauty, ay, the sublimity of the passage of David, which says: "The heavens declare the glory of God," surely geology will enable us to appreciate to the fullest extent the import of another passage, which declares: "The earth also is full of the goodness of God." In the study of the former we are directed not merely to glance at the shining vault above us, with the naked eye, but by the aid of the telescope, to direct our vision to planets, and orbits and systems, and revolutions, and phenomena, which

impress our minds with a sense of the glory of the Creator. In the study of the latter we are invited not merely to glance at the surface of our globe, and contemplate its present inhabitants, but to examine it from its surface to its deepest foundations,—to bring up the records of the past, and to discover that the God of human history is the God of pre-existing ages.

“Maker and Monarch, and Sovereign of all.”

The present state of our globe is but a *continuation* of a series of evolutions, the beginning, progress, and end of which evince the attributes of Him who is from everlasting to everlasting, the God “in whom we live, and move, and have our being.”

The ages past, with all their changes, affecting the animal, vegetable, and mineral kingdoms, are the witnesses which have been with God from the beginning. In all periods, *earth, water, and life*—and these three are one—uniting in testimony to exhibit the truth of the inspired oracles concerning the being and natural attributes of the Creator.

Atheism and Polytheism find no support in the structure of the earth or its ancient history; but, plains and rivers, mountains and valleys, volcanoes and earthquakes, all proclaim: *There is one God.*

In the language of the eloquent Guyot: “All is

order, all is harmony in the universe, because the whole universe is a thought of God."

The benevolence of the Deity and the unity of his great plan, go hand in hand. The one addresses itself to the heart of man — the other to his head. The one is moral, the other intellectual.

We close our volume, by suggesting a course of reasoning on this branch of the inquiry.

We may argue the goodness of the Creator and the unity of his mind, touching the earth and its inhabitants:

First.—From the arrangement of strata.

Second.—From the deposit of minerals and metals.

Third.—From the adaptation of animals to the changing condition of the globe.

Fourth.—From the constant operation of the dynamic agents.

The study of the arrangement of rocks shows us that, although there are miles of strata piled up one on another—the construction of the pile is such that man can reach every part and parcel. By *dip* and *outcrop*, and *escarpment*, we have every group brought to the surface, and thus we obtain marble and limestone, and sandstone, and clay, and sand, and loam, and all other material needed for comfort or ornament.

The study of mineral and metal deposits will con

vince us that, as a general rule, every mineral and every metal has its place, and, that those minerals and metals which are most useful, (coal and iron,) are most abundant, and most widely diffused. All that man is required to do, is to reach forth his hand, take the treasure, and use it for his own interest.

The study of animal adaptation embraces the whole range of Palæontology, as well as the science of Zoology, based upon the existing animal creation.

All the arguments adduced by writers on Natural Theology, to show the adaptation of living animals to their surroundings, and the adjustment of the physical elements to their organic constitution, apply with equal force to animate existence before the human era. Some writers have endeavored to show, that, in all the past ages of the globe, as well as in the present age, animals have enjoyed a remarkable *independence* of external circumstances; but, we may ask, what is this independence but a form of adaptation? For example, the Arctic fox is very independent of heat. Why? Because he has a constitution which enables him to resist cold; hence, he is adapted to the climate in which he lives. The cold suits him, and he suits the cold. It is so with every animal, man not excepted. It has been so in all periods of the world's history before and since man.

Mutations of climate harmonize with mutations of animal life ; destruction of old species and creation of new ones, make the passing away of one age and the introduction of another.

These changes indicate the existence of a Creator and the manifestation of his goodness.

Finally, the constant operation of the great forces, though varying in intensity at different times, exhibits the consummate wisdom of Him, who from the beginning saw the end, and provided a system of laws perfectly adequate to control the agency of physical forces, and to contribute to the temporal happiness of man.

“O Lord, how manifold are thy works ; in wisdom hast thou made them all ; the earth is full of thy riches.”

GLOSSARY.

A.

ACALEPHA. (*Akalephe*, nettle.) Gelatinous zoophyte, living in the ocean. They sting the skin like nettles.

ACEPHALOUS. (*A*, without, and *cephale*, a head.) The Acephala or Acephals, are all these molluscous animals which are without heads, as the oyster and common mussel.

ACROGENS. (*Acron*, the top, and *genesis*, growth.) Flowerless plants growing from the top, whose stems do not increase much in size, such as the mosses, ferns, etc.

ALLUVIUM AND ALLUVION. (*Alluo*, to wash, and *alluvio*, a flood.) Earth, sand, gravel, loam, vegetable mould, etc., washed away by floods and rivers, and deposited upon any older formation.

ALUMINOUS. Containing alum. The clay slates are very frequently impregnated with alum. They are then called *aluminous slates or shales*.

AMMONITE. An extinct genus of Cephalopods like the Nautilus, found in the Secondary or Mesozoic rocks.

AMORPHOUS. (*A*, without, and *morphe*, form.) Bodies having no regular crystalline form.

AMYGDALOID. (*Amygdala*, an almond, and *eidos*, like.) A trap rock containing agates and other minerals scattered through it like almonds in a cake.

ANDROZOIC. (*Andros*, of man, and *zoe*, life.) The age of human life. The human period.

ANOPLOTHERIUM. (*Anoplos*, unarmed, and *therion*, a wild beast.) An extinct quadruped of the Pachyderm order, somewhat like a pig. It had no means of defence.

ARACHNIDANS. (*Arachne*, a spider.) A class of insects.

ARENACEOUS. (*Arena*, sand.) Sandy.

- ARGILLACEOUS.** (*Argilla*, clay.) Composed of clay.
- ASTEROIDS.** (*Aster*, a star, and *eidos*, resemblance.) Radiated animals resembling star fishes.
- AUGITE.** A dark-green or blackish mineral, forming a part of several volcanic rocks.

B.

- BASALT.** A trap rock composed of augite and feldspar, often found in columns, as the Giant's Causeway in Ireland.
- BACULITE.** A fossil, straight-chambered, conical, elongated symmetrical shell, found in the Cretaceous formation.
- BATRACHIAN.** (*Batrachos*, frog.) A class of reptiles including the frog.
- BELEMNITE.** An extinct Cephalopod, having a straight tapering shell, found in the Mesozoic rocks, particularly in the Oolite and chalk.
- BELLEROPHON.** An extinct Cephalopod, found in the mountain limestone (coal formation.)
- BOULDERS.** Large rounded blocks of stone lying on the surface, or superficially imbedded, usually composed of granite material, and evidently transported from their original position.
- BRACHIOPOD.** (*Brachion*, an arm, and *Pous*, a foot.) Bivalve molluscs which have arms for feet. The *Terebratula* is the most familiar example.

C.

- CALAMITE.** A genus of fossil plants found almost entirely in the coal formation. They had large cylindrical stems, articulated or jointed, sometimes attaining a diameter of fourteen inches.
- CALCAREOUS.** Containing lime.
- CARBONATE.** Combination of carbonic acid with a base, as carbonate of lime.
- CARBONIFEROUS.** (*Carbo* and *fero*. Containing carbon.) The great coal formation is called, by pre-eminence, the Carboniferous formation, because it holds or contains an immense quantity of carbon.
- CEPHALOPODA.** Cephalopods—(*cephale*, head, and *poda*, feet.) Molluscous animals with univalve shells, having their feet or organs of motion placed around the head.
- CETACEA ;** Cetaceous animals. Whales, dolphins, etc. They belong to the mammals.

- CHALK.** White earthy carbonate of lime.
- CHELONIAN.** (*Kelonee*.) Tortoise or turtle.
- CONGENERS.** Species which belong to the same genus.
- CONGLOMERATE.** A mass of fragments united by cement. Water-worn fragments of rock cemented by iron and silex.
- CONIFERS.** Trees bearing cones, as pines, firs, junipers, cypresses, cedars, etc. They belong to the *Gymnogens*.
- CRAG.** A deposit of the older Tertiary formation, consisting of sand and shells. That which contains a great deal of coral is called Coralline crag.
- CRINOIDS.** (*Crinon*, a lily, and *idos*, form.) Polyps having lily-like looking heads, such as the Encrinites.
- CRUSTACEOUS animals.** Those having an external crust or shell-like covering, such as crabs, lobsters, and shrimps.
- CYATHOPHYLLUM.** (*Kuathos*, a cup, and *phullon*, a flower.) A genus of fossil corals.
- CYCADS or *Cycadææ*.** A genus of plants holding an intermediate place between the palms, ferns, and conifers. They are rather anomalous in their structure, being gymnogens in respect of ovules—neither oxogenous nor endogenous in their stumpy branched trunks, and having dicotyledonous seeds.
- CYCLOID.** (*Cuclos*, circle, *idos*, form.) Fishes whose scales are smooth and circular, as the salmon and herring.

D.

- DEBRIS.** Rock-remains; applied to large fragments detached from rocks and accumulated in masses.
- DETRITUS.** Sand, gravel, clay, etc., worn off from rocks by water.
- DICOTYLEDONS.** Plants having two seed tubes, as the oak, garden bean, etc.
- DIKE.** A wall of mineral matter cutting through strata in a vertical, or nearly vertical direction.
- DILUVIUM, DILUVIAL, DILUVIAN.** Pertaining to the deluge. These terms have been employed by geologists to designate the sand, gravel, boulders, etc., scattered over the Northern Hemisphere north of about 40°, under the belief that they were deposited by Noah's deluge. This theory is now almost universally abandoned, and all these accumulations come under the name of *Drift*.

DINOTHERIUM. (*Dinos*, terrible, and *therion*, wild beast.) A fossil quadruped of very large size, armed with large tusks, found in the Tertiary formation.

DIP. The downward inclination of strata.

E.

ECHINODERM. (*Ekinos*, hedgehog, and *derma*, skin.) A radiated animal having spines or tubercles on the integument, as the sea urchin, star fish, etc.

EDENTATA. (*E*, without, and *dens*, a tooth.) A class of mammals without teeth in front.

ENCRINITE. (*En*, in, and *krinon*, a lily.) Fossil radiates resembling a lily.

ENDOGENOUS. Plants growing on the inside of the stem. Cornstalk, palm, etc.

EOCENE. (*Eose*, dawn, and *kainos*, recent.) Strata containing fossils, some few of which resemble existing forms. Applied to the Lower Tertiary.

EPOCH. The period during which a formation was produced. Thus we speak of the epoch of the Coal formation, which probably embraced several hundred thousand years.

EQUISETACEÆ. (*Equus*, horse, and *seta*, hair,) resembling horse-hair. A natural order of plants.

ESCARPMENT. The steep face presented by the abrupt termination of strata.

EXOGENOUS. Plants growing on the outside. Oaks, hickories, and all our forest trees.

F.

FAULT. A solution of continuity, or a sudden break or interruption occasioned by fracture. It is owing to upheaval. The strata, in such cases, are generally inclined in opposite directions, and one part more elevated than the other. Faults often occur in coal mines.

FAUNA. (*Faunus*. A rural deity among the Romans.) The animals peculiar to a region constitute its fauna.

FAVOSITES. (*Favus*, honey-comb.) The generic name of fossil corals, resembling honey-comb.

FERRUGINOUS. Containing iron.

FLORA. (Goddess of flowers.) The vegetation of a country is called its flora.

Fossil. (*Fossilis*, that which may be dug up.) Organic body—animal or vegetable, buried by natural causes.

Fossiliferous. Containing fossils

G.

GANOID. (*Ganos*, brightness, and *eidōs*, form.) Fishes having bright angular scales.

GASTEROPODS. (*Gaster*, the abdomen, and *poda*, feet.) Molluscan animals which use the abdomen for feet, as the snail.

GYMNOGENS. (*Gymnos*, naked, and *genesis*, production.) All plants are so called that come forth, not having the seed enveloped, as pines, hemlocks, spruces, etc.

H.

HABITAT. The natural residence of an animal or plant.

HELIX. (*Eliz*, a wheel.) The generic name of snails.

HETEROCERCAL. (*Eteros*, opposite, and *kerkos*, a tail.) Fishes having unequal bilobed tails—the spine being prolonged into the tail. Nearly all the fossil fishes are heterocercal.

HOMOCERCAL. (*Homos*, the same, and *kerkos*, a tail.) Fishes with equal lobed tails. The spine is not prolonged into the tail. Nearly all of our fishes are homocercal.

HOMOLOGY. Affinity of structure. The wing of a turkey is homologous to the arm of a man.

I.

ICHTHYOSAURUS. (*Ichthuse*, fish, *saura*, lizard.) A gigantic extinct marine animal, partaking of the nature of a crocodile and fish.

IGUANODON. A large saurian, resembling the iguana, found in the south of England.

INFUSORIA. (*Infundo*, I pour in.) Microscopic animalcules, developed in infusions of decayed animal and vegetable matter.

K.

KAINOZOIC. (*Kainos*, recent; and *zoe*, life.) Strata and included fossils, which exhibit animal and vegetable forms similar to the recent or historical. They include the Tertiary and post Tertiary.

L.

LABYRINTHODON. (*Laburinthos*, a labyrinth, and *odous*, tooth.) An extinct genus of batrachian, remarkable for the complicated structure of its teeth.

LACERTIAN. A lizard.

LACUSTRINE. Belonging to lakes.

LEPIDODENDRON. (*Lepis*, a scale, and *dendron*, tree.) A scaly bark fossil plant found in the coal beds.

LICHEN. Moss on trees or rocks.

LIMNEA AND LYMNEA. (*Limne*, a pool.) A genus of fresh-water snails, found usually in pools and spring branches.

LIGNITE. A sort of coal, of woody texture, found in the Tertiary formation. No value.

LITTORAL. Belonging to the shore

LOAM. A mixture of sand and clay.

M.

MADREPORE. Branching coral.

MAMMALS. Vertebrated animals which suckle their young.

MARL. Calcareous earth; a combination of lime and clay.

MARSUPIALS. Animals having a pouch for their young, as the kangaroo and opossum.

MASTODON. (*Mastos*, nipple, and *odous*, tooth.) A gigantic fossil quadruped, resembling the elephant, and named from the conical protuberances on the grinders.

MEGALONYX. (*Megas*, great, and *onux*, a claw.) A large fossil mammal, found in Virginia, and described by Mr. Jefferson. It had tremendous claws.

MEGALOSAURUS. (*Megas*, great, and *sauros*, reptile.) A huge saurian, whose remains are found in the Oolite and Wealden. It was about thirty feet long.

MEGATHERIUM. (*Megas*, great, and *therion*, wild beast.) An extinct fossil quadruped, eighteen feet long, and nine feet high.

MELANIA. Fresh-water gasteropods, known by the name of periwinkle.

MESOZOIC. (*Mesos*, middle, and *zoe*, life.) Pertaining to the Middle ages of life. The Secondary rocks.

- METAMORPHIC.** (*Meta*, over again, and *morphe*, form.) Rocks transformed by heat.
- MIOCENE.** (*Meion*, less, and *kainos*, recent.) The Middle Tertiary group of rocks, in which a minority of the shells are of recent species.
- MOLLUSCA.** (*Mollis*, soft.) Animals with soft bodies, most of them living in shells, as the oyster and mussel.
- MONAD.** (*Monos*, one, unity.) The smallest of animalcules.
- MONOCOTYLEDON.** A plant whose seeds have but one seed lobe, as corn and wheat.
- MORaine.** The debris of rocks deposited from glaciers, scattered about in valleys.

P.

- PACHYDERMS.** (*Pachuse*, thick, and *derma*, skin.) Thick-skinned animals, as the elephant, horse, hog, etc.
- PALÆONTOLOGY.** (*Palaïos*, ancient; *onta*, beings; and *logos*, a discourse or description.) The science of fossil remains.
- PALÆOTHERIUM.** (*Palaïos*, ancient; and *therion*, beast.) The generic name of a fossil mammal belonging to the pachyderms, found in the Tertiary.
- PALÆOZOIC.** (*Palaïos*, ancient, and *zoe*, life.) A name applied to the most ancient organic remains and strata, including all the groups named as Primary Fossiliferous, viz.: the Silurian, Devonian, Carboniferous, and Permian.
- PALUDINA.** (*Palus*, a marsh.) A genus of fresh-water gasteropods, with univalve spiral shell.
- PEAT.** Accumulation of vegetable matter on and near the surface of the earth in moist places. It appears to be a substance intermediate between pure vegetable matter and lignite, 80 parts in 100 are combustible.
- PLACOID.** (*Plax*, plate, and *eidōs*, form.) An order of fishes whose scales resemble enamelled plates.
- PLANORBIS.** (*Planus*, flat, and *orbis*, a circle.) A genus of marsh snails, having a flat discoidal shell.
- PLESIOSAURUS.** (*Plesion*, near, and *saura*, lizard.) An extinct amphibious animal, resembling a lizard. It lived during the Oolitic era. It was about twenty feet long.

PLIOCENE. (*Pleion*, more, and *kainos*, recent.) The Upper Tertiary formation is so called, because a majority of the shells found therein belong to extinct species.

PLEISTOCENE. (*Pleistos*, most, and *kainos*, recent.) The newest Tertiary rocks, or Quaternary. All the shells belong to existing species.

POLYP. (*Polus*, many, and *pons*, a foot.) Radiated animals having many feet or feelers.

PORPHYRY. (*Porfura*, purple.) A crystallized unstratified rock, containing crystals of feldspar and other minerals. It is of various colors.

PTERODACTYL. (*Pteron*, wing, and *dactulos*, finger.) A bat-like animal of the Liassic era. A flying saurian.

PUPA. A genus of snails.

Q.

QUADRUMANA. (*Quatour*, four, and *manus*, hand.) Four-handed animals — monkeys, apes, etc.

QUATERNARY. (*Quaternarius*, four.) Relating to four, succeeding by fours. A term adopted by some geologists to designate the Pleistocene or newest Tertiary. It is not used by English authors.

QUARTZ. Oxide of silicon. Pure silica or siliceous. The crystal is a six-sided prism, terminated with six-sided pyramids. It is often found compact and amorphous. The crystals are usually clear like glass; but frequently they are colored yellow, rose, violet, and smoky.

R.

RADIATES. The lowest animals. The name is given because of their radiated configuration.

RAG. Coarse, shelly limestone.

RAYS. Fishes of a flattened discoidal shape, without ribs, as the skate and torpedo.

RECENT. This term is applicable to any thing embraced in the human period. All species, animal or vegetable, which have existed since the creation of man, are considered recent.

ROCK. Any mineral aggregate, whether clay, chalk, limestone, or granite. Metals, such as gold and silver, are not called rocks.

RUMINANTS. (*Rumino*, to chew over.) Animals that chew the cud.

S.

- SAURIAN.** (*Sauros*, lizard.) Any reptile of the lizard kind.
- SAUROID.** (*Sauros*, lizard, and *eidos*, form.) This name is applied to animals resembling lizards.
- SCHIST.** A general name given to various minerals which split and divide into layers or plates.
- SHALE.** An indurated slaty clay.
- SILT.** Accumulation of sand, clay, earth, and vegetable matter in running waters.
- SIGILLARIA.** (*Sigillum*, seal.) Fossil trees, whose bark is covered with impressions as if made with a seal. The roots are called *stigmaria*.
- SPAR.** A name applied to various mineral substances which break into crystalline forms
- STALACTITE.** (*Stalazo*, to drop.) Mineral accumulations, formed in caves by the dropping of limestone water, and hanging from the roof like icicles.
- STALAGMITE.** Accumulations on the floor of a cavern, from the dropping of water holding limestone in solution.

T.

- TEREBRATULA.** (*Terebro*, to bore.) Fossil and living—found in all formations—a genus of bivalve mollusc, having a perforated shell, through which it may thrust its arm to act as a foot.
- TESTACEA.** (*Testa*, shell.) Animals with shells for a covering.
- THALLOPHYTES.** (*Thallos*, twig, and *phuo*, to grow.) Twig-shaped, branching—comprises the sea-weeds, mosses, lichens, etc.

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